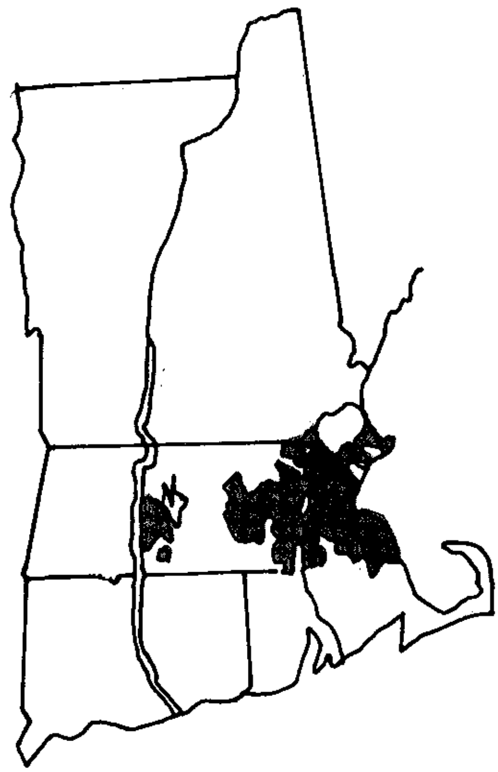
# NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

## FINAL ENVIRONMENTAL STATEMENT

## NORTHFIELD MOUNTAIN AND MILLERS RIVER DIVERSION



AUGUST 1976

Public Law 89-298
89th Congress, S. 2300
October 27, 1965

# An Act

Authorizing the construction, repair, and preservation of certain public works on rivers and harbors for navigation, flood control, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

## TITLE I—NORTHEASTERN UNITED STATES WATER SUPPLY

SEC. 101. (a) Congress hereby recognizes that assuring adequate supplies of water for the great metropolitan centers of the United States has become a problem of such magnitude that the welfare and prosperity of this country require the Federal Government to assist in the solution of water supply problems. Therefore, the Secretary of the Army, acting through the Chief of Engineers, is authorized to cooperate with Federal, State, and local agencies in preparing plans in accordance with the Water Resources Planning Act (Public Law 89-80) to meet the long-range water needs of the northeastern United States. This plan may provide for the construction, operation, and maintenance by the United States of (1) a system of major reservoirs to be located within those river basins of the Northeastern United States which drain into the Chesapeake Bay, those that drain into the Atlantic Ocean north of the Chesapeake Bay, those that drain into Lake Ontario, and those that drain into the Saint Lawrence River, (2) major conveyance facilities by which water may be exchanged between these river basins to the extent found desirable in the national interest, and (3) major purification facilities. Such plans shall provide for appropriate financial participation by the States, political subdivisions thereof, and other local interests.

(b) The Secretary of the Army, acting through the Chief of Engineers, shall construct, operate, and maintain those reservoirs, conveyance facilities, and purification facilities, which are recommended in the plan prepared in accordance with subsection (a) of this section, and which are specifically authorized by law enacted after the date of enactment of this Act.

(c) Each reservoir included in the plan authorized by this section shall be considered as a component of a comprehensive plan for the optimum development of the river basin in which it is situated, as well as a component of the plan established in accordance with this section.

# NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

FINAL

ENVIRONMENTAL STATEMENT

## NORTHFIELD MOUNTAIN AND MILLERS RIVER DIVERSION

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

SEPTEMBER 1976

SUMMARY SHEET

NORTHFIELD MOUNTAIN DIVERSION
MILLERS RIVER DIVERSION
NORTHEAST WATER SUPPLY STUDY

( ) Revised Draft (X) Final Environmental Statement

Responsible Office: U. S. Army Engineer Division, New England, Waltham, Massachusetts

1. Name of Action: ( ) Administrative (X) Legislative (Federal)

2. Description of Action: Involves solutions for meeting future water supply requirements for Eastern Massachusetts and explores various alternative ways to meet the projected needs for this region. Proposals include diversion during high flow periods from the Connecticut River via the Northfield Mountain pumped-storage facility directly to Quabbin Reservoir and by three other alternative methods to utilize and transport water from the Millers River Basin to the Quabbin Reservoir.

3. a. Environmental Impacts: Implementation would assure availability of projected water requirements for Eastern Massachusetts. Provides means to keep water quality high in Quabbin Reservoir by slowing down present depletion rate. An increased nutrient level in Quabbin Reservoir is expected. Depending on the alternate chosen, certain lands and waters will be dedicated to water supply in the Millers River Basin. Millers River water quality will be improved under two alternatives. May create a shift in present fishing patterns in Quabbin Reservoir. High diversion rates would cause appreciable loss of flow in the mainstem Millers River during portions of the diversion period.

b. Adverse Environmental Impacts: May include a temperature rise below the diversion point on the Millers River as well as a probable lessening of the sediment load and a partial loss of flushing action in the stream. No adverse effects are predicted for the mainstem of the Connecticut River or its estuary. No significant changes are predicted for Quabbin Reservoir. Some biota will become entrapped or entrained by the Northfield pumped-storage project.

4. Alternatives:

a. No Action
b. Weather Modification
c. Desalinization
d. Importation
e. Wastewater Reuse
f. Ground Water Resources
g. Dual Water Supply Systems
h. Other Diversion Sites
i. Water Demand Control
j. Re-examination of Release Schedules
k. Local Resource Potential
l. Population Zoning and Regulations

5. Comments requested (See attached sheets)

6. Draft statement sent to CEQ 11/14/72.
Final statement sent to CEQ __________.

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## Plates



A glossary of Ecological Terms is included at the end of Section Eight.

## Tables

## 5. Comments Requested (247)

### Federal

First Coast Guard District
Federal Aviation Administration
Department of the Interior
Soil Conservation Service
Environmental Protection Agency
Federal Highway Administration
Bureau of Sport Fisheries & Wildlife
Department of Commerce
National Marine Fisheries Service
Office of Economic Opportunity
Federal Power Commission
New England River Basins Commission
U.S. Geological Survey
Department of Health, Education and Welfare
Department of Housing and Urban Development
National Park Service
Bureau of Outdoor Recreation
U.S. Department of Transportation
North Atlantic Division, Corps of Engineers

### State

Conn. Water Resources Comm.
Conn. Office of State Planning
Conn. Board of Fisheries and Game
Conn. Department of Environmental Protection
Conn. Department of Community Affairs
Conn. Department of Public Health
Conn. Shell Fish Commission
Conn. Department of Agriculture
Conn. Institute for Water Resources
Hartford Metropolitan District Comm.
Mass. Office of Planning and Programming Coordination
Mass. Department of Public Works
Mass. Department of Natural Resources
Mass. Department of Water Resources
Mass. Division of Fisheries & Game
Mass. Department of Public Health
Mass. Agricultural Experiment Station
Mass. State Geologist
Mass. Water Resources Research Center
Mass. State Research Director
Mass. Department of Commerce and Development
Mass. Department of Community Affairs
Boston Metropolitan District Comm.

State (Cont'd)

N.H. Water Supply and Pollution Control Comm.
N.H. Water Resources Board
N.H. Fish & Game Department
N.H. Water Resources Research Center
N.H. Office of State Planning
Office of the Governor of N.H.
N.H. Natural Resource Council
N.H. Department of Public Health
R.I. Water Resource Center
R.I. Department of Natural Resources
R.I. Department of Health
R.I. Statewide Planning Program
R.I. Water Resources Board
Vt. Resource Research Center
Vt. Department of Water Resources
Vt. Planning and Community Services Agency
Tri-State Transportation Comm.
Southern N.H. Planning Comm.
R.I. State Comp. Trans. & Land Use Planning Program
Connecticut Regional Planning Agencies
- Capital
- Central
- Southeastern
- Conn. River Estuary
- Litchfield Hills
- Midstate
- Northeastern
- Windham
- Greater Bridgeport
- Central Naugatuck Valley
- Southwestern
- Valley
- South Central
- Conn. Interregional Planning Program

Massachusetts Regional Planning Agencies
- Metropolitan Area
- Old Colony
- Southeastern
- Montachusetts
- Central Merrimack Valley
- Northern Middlesex Area
- Berkshire
- Lower Pioneer Valley
- Central Massachusetts
- Cape Cod
- Dukes County
- Franklin County

Private Organizations

Portland Water District
Connecticut Water Company
Massachusetts Audubon Society
Anderson-Nichols, Inc.
Union of Concerned Scientists, MIT
New England Natural Resources Center
League of Woman Voters, Mass.
League of Woman Voters, Conn.
Charles River Valley Group of the L.W.V.
Curran Associates, Inc.
Normandeau Associates, Inc.
The Maine Assoc. of Conservation Comm.
WCAT-Berkshire Broadcasting
Orange Enterprise & Journal
Orange Board of Health
Abt Associates, Inc.
Essex Marine Laboratory, Inc.
Associated Industries of Mass.
New England Water Works Assoc.
American Water Works Assoc., Inc.
Salem and Beverly Water Supply Board
Westfield River Watershed Assoc.
Trout Unlimited
Millers River Watershed Council
Fenton G. Keyes Assoc.
Broadmoor Sanctuary
Nashua River Program
Massachusetts Wildlife Federation
Worcester Telegram and Gazette
The Outdoor Message
National Wildlife Federation
Appalachian Mountain Club
Water Department, Cambridge
Ipswich River Watershed District Comm.
Conn. River Valley Flood Control Comm.
Merrimack River Valley Flood Control Comm.
Thames River Valley Flood Control Comm.
Conn. River Watershed Council, Inc.
Parker River Watershed Council
Farmington River Watershed Assoc.
Housatonic River Watershed Assoc.
Canoe River Watershed
Mystic River Watershed Assoc.
North and South Rivers Watershed Assoc.
Ad Hoc Committee
Blackstone Valley Watershed Assoc.
Charles River Watershed Assoc.
League of Woman Voters of R.I.
League of Woman Voters of N.H.
League of Woman Voters of Vt.

Private Organizations (Cont'd)

Conn. Assoc. of Conservation Comm., Inc.
Conn. Audubon Council
Conn. Forest and Park Assoc., Inc.
The Nature Conservancy, N.H.
Council of Sportsmen's Clubs of Mass., Inc.
Mass. Assoc. of Conservation Districts
Mass. Forest and Park Assoc.
The Trustees of Reservations
Federated Sportsmen's Clubs of N.H., Inc.
Audubon Society of N.H.
Land Use Foundation of N.H.
N.H. Assoc. of Soil Conservation Districts
N.H. Natural Resources Council, Inc.
Seacoast Anti-Pollution League, N.H.
Society for the Protection of N.H. Forests
Statewide Program of Action to Conserve Our Environment, N.H.
Audubon Society of R.I.
Environmental Council of R.I., Inc.
R.I. Assoc. of Soil and Water Conservation District Supervisors
Vermont Natural Resouces Council
Merck Forest Foundation, Inc.
The Nature Conservancy, Vt.
Vermont Assoc. of Conservation Districts
Environmental Protection Comm., Conn.
N.E. Research, Inc.
Mass. Water Works Assoc.
New England Natural Resources Center
Worcester County League of Sportsmen
Merrimack Valley Region Assoc.
Agency of Environmental Conservation, Vt.
Conn. River Estuary R.P.A.
Ipswich River Water District
Neponset Conservation Assoc.
Westport River Improvement Assoc.
Essex County Greenbelt Assoc.
Tenmile River Task Force
Lake Cochituate Watershed Assoc.
Reading Greenbelt Assoc.
Orange Conservation Comm.
Civil Engineering Dept. , Univ. of Conn.
Marine Resources Committee
Coastal Research Center , Univ. of Mass.
National Foundation For Environmental Control
Sierra Club
Environment Inform. Ctr, Inc.
New York Times
Greater Boston Ecology Action Ctr.
Metropolitan Area Plng. Council
Nashua River Watershed Assoc.
Mass. Port Authority

Private Organizations (Cont'd)

Conn. Wildlife Federation, Inc.
Save The Wetlands Committee, Ct.
Conn. Action Now, Inc.
Conn. Audubon Society
Conn. Assoc. of Soil and Water
Conservation Districts, Inc.
N.H. Water Works Assoc.
Environmental Conservation
Middlesex Conservation District

(Private Citizens)

Mr. Robert Gray
Mrs. Charles Carver
Mr. Warren Sinclair
Mr. Paul Mallet
Mr. Allan Hawk
Mr. William Thorpe
Col. George Baker
Mr. George Pushee
Mr. Duane Leonard
Mr. Henry Waidlich
Rep. Thomas G. Simons
Mr. Frederick J. Muehl
Mr. Glenn W. Stewart
Mr. John S. Yantosca
Mr. Joseph C. Broyles
Mr. John F. Healey
Mrs. Allie Quinn
Harlan Logan
Mr. James Erving, Publisher
Gordon Tiffany, Esq.
Mr. Philip J. Holton
A.P. Drury
M.A. Casella
C. Russell Shaw
Richard F. Chase
Earl R. Drew, Jr.
Mr. William Whitehorse
J.F. McCann
Mr. Peter Amato
Mr. Arthur Delage
Mr. Wesley C. Vokey
Mr. Lorrin Pittendreigh
Mrs. Joseph M. Dare
Mrs. Edward DeMarrais
Mr. Richard A. Boucher
Mrs. Paul LaRoche
Mrs. Joan Ashwell
Mrs. Elma E. Baker

(Private Citizens)(Cont'd)

Mrs. Janice Corser
Jean A. Simonian
Mr. Philip C. Smith
Mrs. Herbert Vollertson
M.E. Willson
Mr. Leon J. Winchill
Priscilla Winehill
Lionel Zamore
Mr. Peter M. Lynch
Ms. Barbara L. Buhts
Mr. David Stickel
Mrs. William White

A. Comments Received:

Federal:

U.S. Department of Agriculture, Soil Conservation Service
Department of Housing and Urban Development
U.S. Department of Transportation, Federal Highway Administration
Federal Power Commission
Office of Economic Opportunity
U.S. Environmental Protection Agency
U.S. Department of Commerce
U.S. Department of the Interior:
- Bureau of Mines
- Bureau of Outdoor Recreation
- Bureau of Sport Fisheries and Wildlife
- National Park Service

State of Connecticut:

Department of Environmental Protection

Commonwealth of Massachusetts:

Metropolitan District Commission
Department of Commerce and Development
Division of Fisheries and Game
University of Massachusetts, Agricultural Experiment Station
Water Resources Commission

State of New Hampshire:

Office of the Governor (State Clearinghouse)
Water Supply and Pollution Control Commission

State of Rhode Island and Providence Plantations:

Statewide Planning Program

Local:

Franklin County, Massachusetts, Department of Planning
City of Hartford, Connecticut
Town of Montague, Massachusetts
Natick Conservation Commission, Massachusetts

Private Organizations:

Connecticut Audubon Council, Inc.
Connecticut Forest and Park Association, Inc.
Connecticut River Watershed Council, Inc.
Lower Pioneer Valley Regional Planning Commission
Massachusetts Audubon Society
Connecticut River Ecology Action Corporation
Millers River Watershed Council, Inc.
League of Women Voters, Holyoke Area, Massachusetts
Lake Cochituate Watershed Association, Inc.
Save Our Streams
League of Women Voters, Massachusetts
Sierra Club, New England Chapter

Private Citizens:

C. Russell Shaw
Jean A. Simoneau
Warren M. Sinclair
David W. Stickel

## INTRODUCTION

The 89th Congress recognized that the assurance of adequate supplies of water for the great metropolitan centers had become a problem of such magnitude that the welfare and prosperity of the United States required the Federal Government to assist in its resolution. Consequently, the Congress enacted the Northeastern United States Water Supply (NEWS) Study on 27 October 1965, under Title I of Public Law 89-298.

A copy of the law, with a map of the study area on its reverse side, is attached. It authorized the Secretary of the Army, acting through the Chief of Engineers, to prepare plans to meet the long range water supply needs of the Northeast, in cooperation with Federal, State and local agencies. The Chief of Engineers, in turn, assigned responsibility for the NEWS Study to the Division Engineer, North Atlantic.

The NEWS Study area includes those river basins within the United States which drain into Chesapeake Bay, into the Atlantic Ocean north of Chesapeake Bay, into the St. Lawrence River, and into Lake Ontario. The study area, therefore, includes all of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, and the District of Columbia, and parts of New York, Pennsylvania, Maryland, Virginia, and West Virginia.

An area of approximately 200,000 square miles, the area contains a population of about 50 million persons, which is projected to reach about 85 million by the year 2020. Some 60 percent of the present population is concentrated in the five metropolitan areas of Boston, New York, Philadelphia, Baltimore and Washington. It includes twenty of the nation's one hundred largest cities. The municipal water suppliers of the region serve populations varying from less than 100 to 8.5 million. Although the area has an average annual precipitation rate of about 40 inches, as compared to the national average of 30 inches, precipitation deficiencies in some parts of the area were up to 50 inches during the October '61 to December '65 period. The area's vulnerability to water shortage is revealed by the fact that some 14 million people, about 28 percent of the population, were restricted to some degree in their use of water during this drought. Although public awareness of the problems of water supply is increased by drought experiences, drought is not the only reason for concern. Available supplies of water of good quality will soon be inadequate, even under normal conditions, to meet the needs of the expanding population and industrial growth.

The objective of the NEWS Study is the preparation of a coordinated general plan for essential water supply development in the Northeast which will recommend to the Congress an active program for Federal, State, local, and private organizations. Such plans shall provide for appropriate financial participation by the States, political subdivisions thereof, and other local interests. It will thus provide a public forum where all vitally concerned with the water supply problems of the area can be heard in developing a plan to resolve one of the domestic problems now facing the United States.

In achieving its objective, the NEWS Study is presenting a regional assessment of present and future water supply needs and will explore alternatives for their solution. The study effort is being fully coordinated through the various Federal, State, local and private agencies and organizations. This coordination will assure that plans are consistent with, and integral to, other concurrent water resource planned development being formulated. Thus, the NEWS Study can provide a framework through which all elements may effectively work together toward securing adequate water supplies. During the study, interim reports will be prepared to deal with critical problems which may be encountered. These reports will contain specific recommendations to the Congress for authorization of major reservoirs, conveyance facilities, or treatment facilities, as may be appropriate. The Northfield Mountain Diversion and Diversion from the Millers River[1] Basin are the studies which are the subject of this revised draft Environmental Statement.

The NEWS Study effort was organized and initiated during the last half of 1966 with the preparation of a plan of study and the acquisition of data and reports. There followed a series of initial public hearings; the development of statistical information on public and private water supplies; a summary of drought information, including restrictions and shortages experienced in various communities; an appraisal of the degree of urgency for additional water supply in various regions of the study area; an analysis of the water supply potential of one selected area by the use of advanced statistical hydrologic techniques; and the initiation of studies in specific urgent regional metropolitan areas.

The NEWS Study has established the premise that areas in which the projected demand for water supply in 1980 will probably exceed the present capabilities of the systems will be considered in the "urgent"

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[1] Both projects are included in the New England River Basins Commission 1980 Connecticut River Basin Plan, January 1972.

category. Under NEWS procedures, projects and regional programs for these urgent areas will be developed and made the subject of interim reports which will be submitted to the Congress for authorization. To identify these urgent areas, an initial appraisal was made of the present systems to satisfy the projected 1980 demands. This appraisal included an evaluation of present system capabilities, present and projected domestic and industrial consumption, population expansion and economic growth. The appraisal disclosed four critically urgent areas as follows:

1) Eastern Massachusetts and Rhode Island

2) Western Connecticut - Metropolitan New York City and Northern New Jersey

3) South Central Pennsylvania, Baltimore

4) Metropolitan Washington, D. C.

Once these critical areas had been identified, feasibility detail studies were initiated to investigate alternative engineering solutions. The western Connecticut area, although in the New England Division, because of its geographic proximity to the Metropolitan New York area was studied in conjunction with that region. The second "urgent" need area within New England, i.e. Eastern Massachusetts, was studied by members of the New England Division.

The Division Engineer, New England Division, cooperated in the NEWS Study by preparing an engineering feasibility study for this area. Aimed primarily at the water short areas of eastern Massachusetts, this study included Rhode Island, since evaluation of a potential regional scheme could involve consideration for the future needs of that state. The study, initiated in December 1968, was performed in consultation with representatives of the States of Massachusetts, Connecticut, Rhode Island, and of the New England River Basins Commission. A report of the study results, the engineering alternatives feasible for the area, was prepared and submitted for review and comment in draft form in November 1969. Following a review period and receipt of the review comments, a meeting was held in May 1970 with representatives of the Federal, State, and local agencies and interests to reach agreement on the best future course for the NEWS Study to pursue in continuing studies in the area.

It was agreed that the Corps proceed with detailed studies on the development of Tully Reservoir; initiate detailed studies on the

Northfield Mountain development to complement studies by the Metropolitan District Commission; initiate studies on the requirements for improving the water quality of the Merrimack River together with a detailed investigation of the use of the River as a possible water supply source for the Eastern Massachusetts area; conduct a broad environmental impact study of water supply alternatives; perform detailed studies of the effect of upstream diversion on the estuaries of the Merrimack and Connecticut Rivers; and explore the possibilities of advance site acquisition in Rhode Island.

In addition to the progress meetings, held during the course of the study, four informal information meetings were held within the Millers River Basin. These meetings were held in Athol, Massachusetts on 21 October 1971 and 4 January 1972; in Winchendon, Massachusetts on 2 March 1972, and in Athol, Massachusetts on 8 May 1972.

During December 1971 and January 1972, a series of four formulation stage public meetings were held in Needham, Woburn, Orange and Longmeadow, Massachusetts. These meetings were designed to broaden public participation in the open planning process by describing the on-going studies and receiving audience input. Some people spoke in favor of the plans presented. Others thought that we should concentrate on reducing demand instead of diverting more water to Eastern Massachusetts. A number of people at the Orange meeting suggested that water be diverted from the Millers River itself after pollution abatement. These ideas and others expressed at the public meetings were investigated as part of our studies and considered in the formulation of all plans. Late Stage Public Meetings were held in Waltham and Orange, Massachusetts on July 5 and 6, 1972.

## ENVIRONMENTAL IMPACT STATEMENT BACKGROUND INFORMATION

This statement consists of an assessment of the environmental resources affected by the Millers and Connecticut River diversions, an analysis of the probable environmental impacts of each plan, and possible alternatives. The study of the Merrimack River Diversion will be the subject of a separate action.

The following pages describe the efforts of an integrated multidiscipline team of Corps of Engineers personnel, Fish and Wildlife Service Biologists, and services from three environmental and socioeconomic impact consulting firms.[1]

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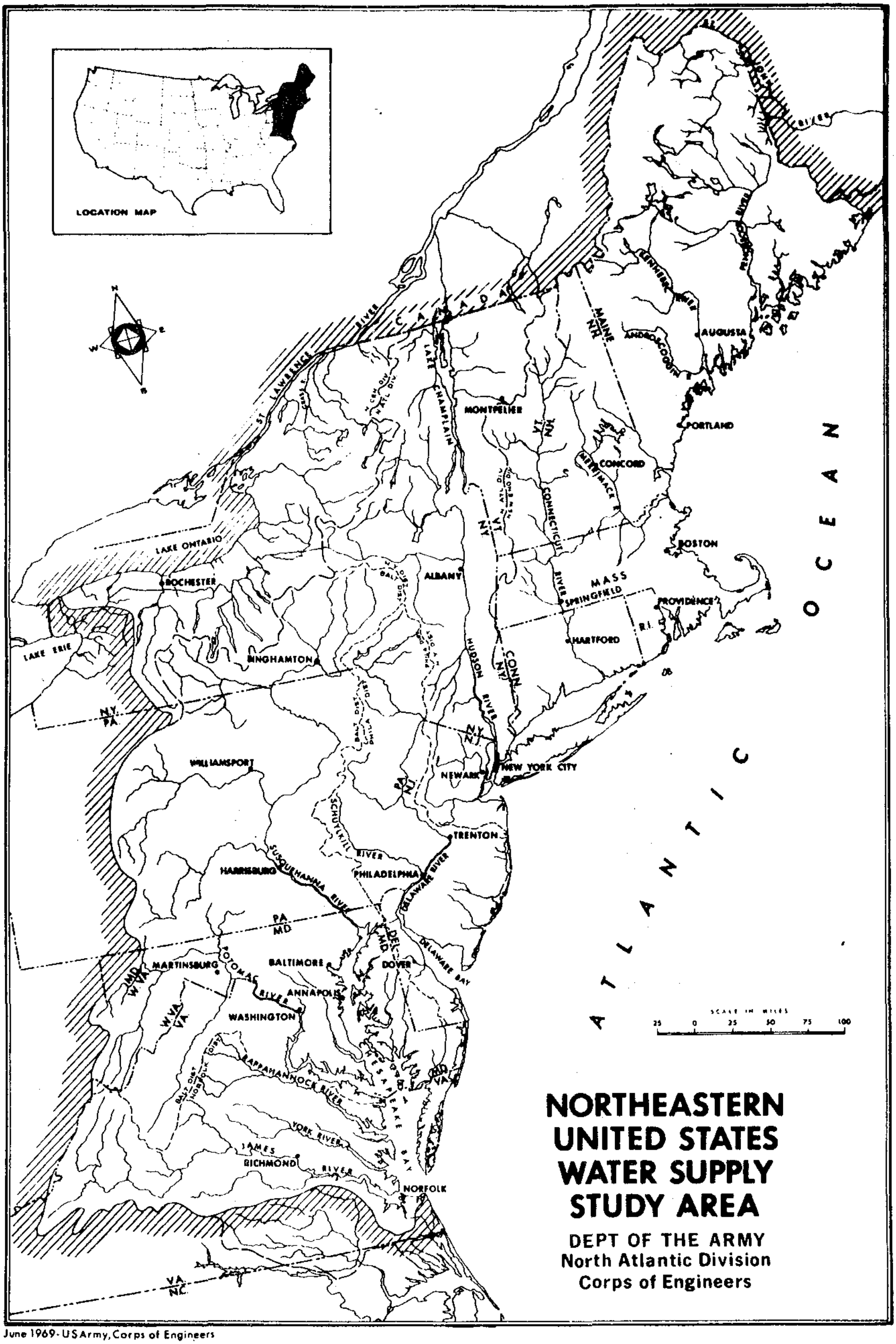
[1] Essex Marine Laboratory, Inc., New England Research, Inc., Abt Associates.

A considerable portion of the available time and effort was devoted during the course of the study to the ecological, environmental, and public health aspects of the various proposals. Section 3 of this statement contains specific detailed information and descriptions of the various analysis used by two environmental consulting firms during the course of the study. Although their complete reports are not included as part of this statement, care has been taken to include all their principal findings and conclusions for the benefit of the reviewer.

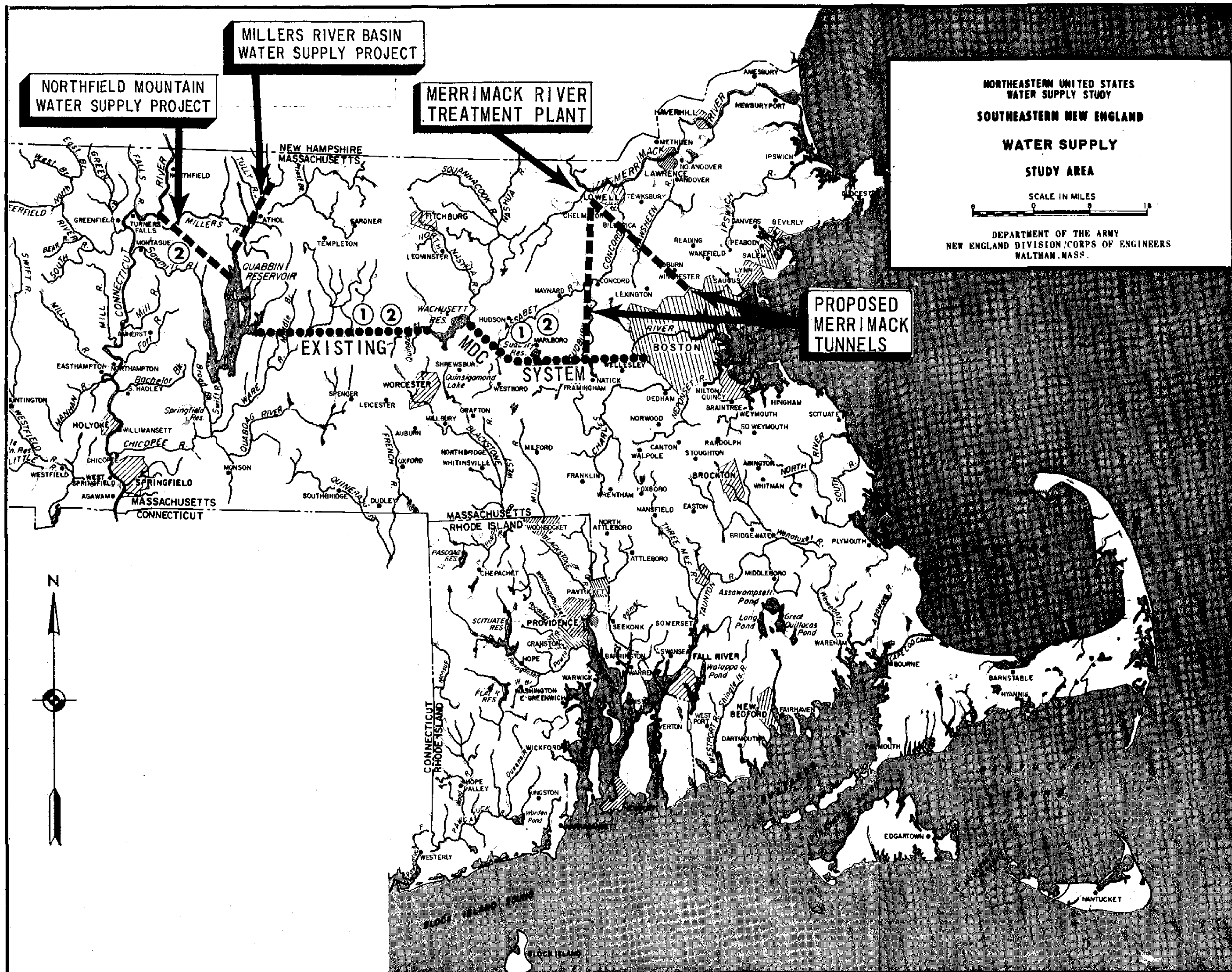
The information contained herein reflects a preliminary assessment of the physical and biological characteristics of each donor and receiver system and the potentially affected resources based on existing knowledge. Some specific details on the probable effect identified for each proposal are still unknown. In addition to public review of each proposed diversion project, a thorough analysis will also be completed by various Federal, State, and local agencies.

The Preliminary Environmental Assessment, which was distributed at the Late Stage Public Meetings, together with detailed environmental data compiled by contracted consulting firms, and information and comments gained at the public meetings, provided the basis for the preliminary draft Environmental Impact Statement for the proposed diversion projects.

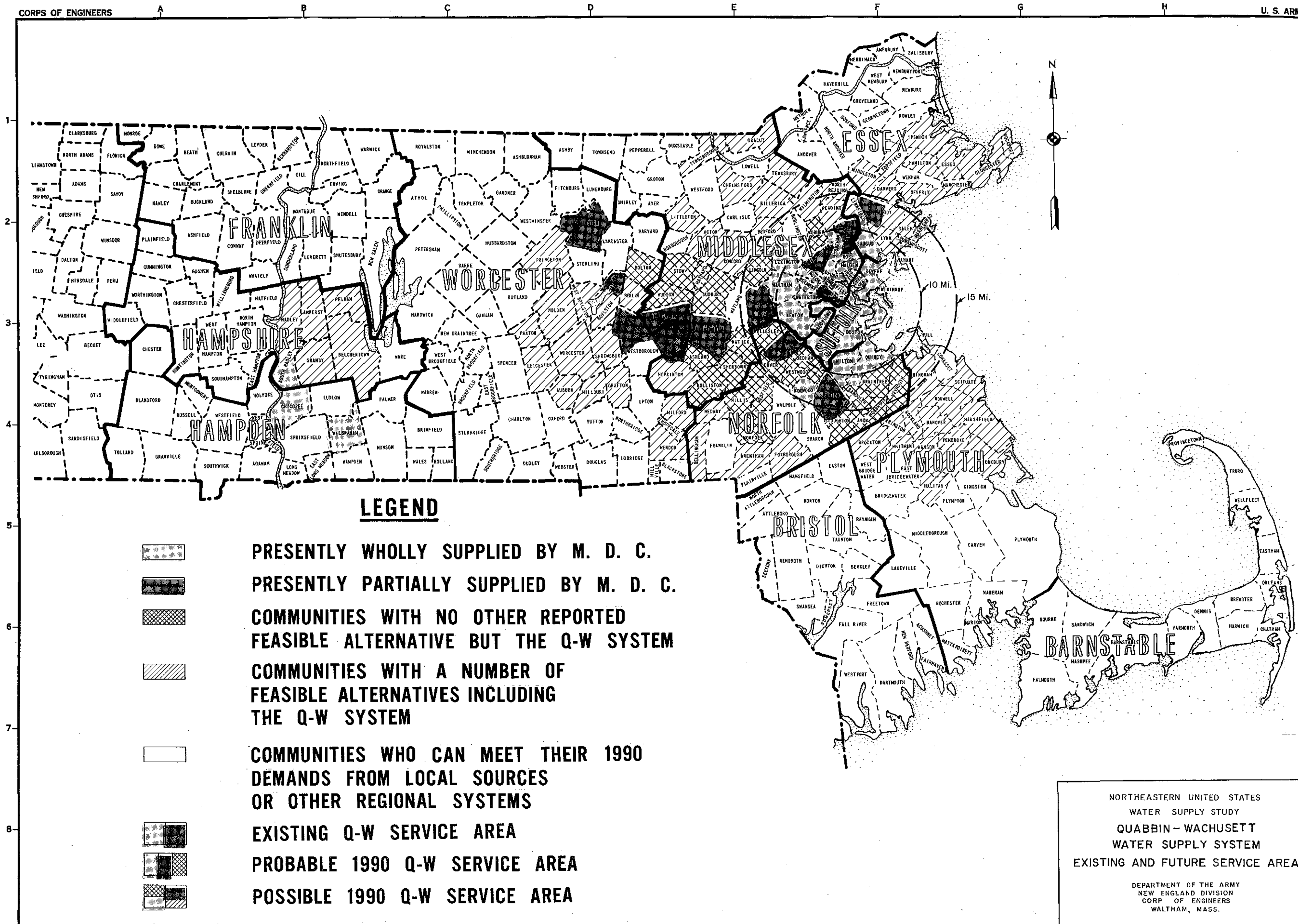
In November 1972, copies of the preliminary draft environmental impact statement were furnished to more than 250 Federal, State, and local and private agencies and organizations. With the end of the review period on 23 December 1972, approximately 40 agencies had responded raising some 200 questions. All correspondence received is found in Section 8 of this Final Environmental Statement.

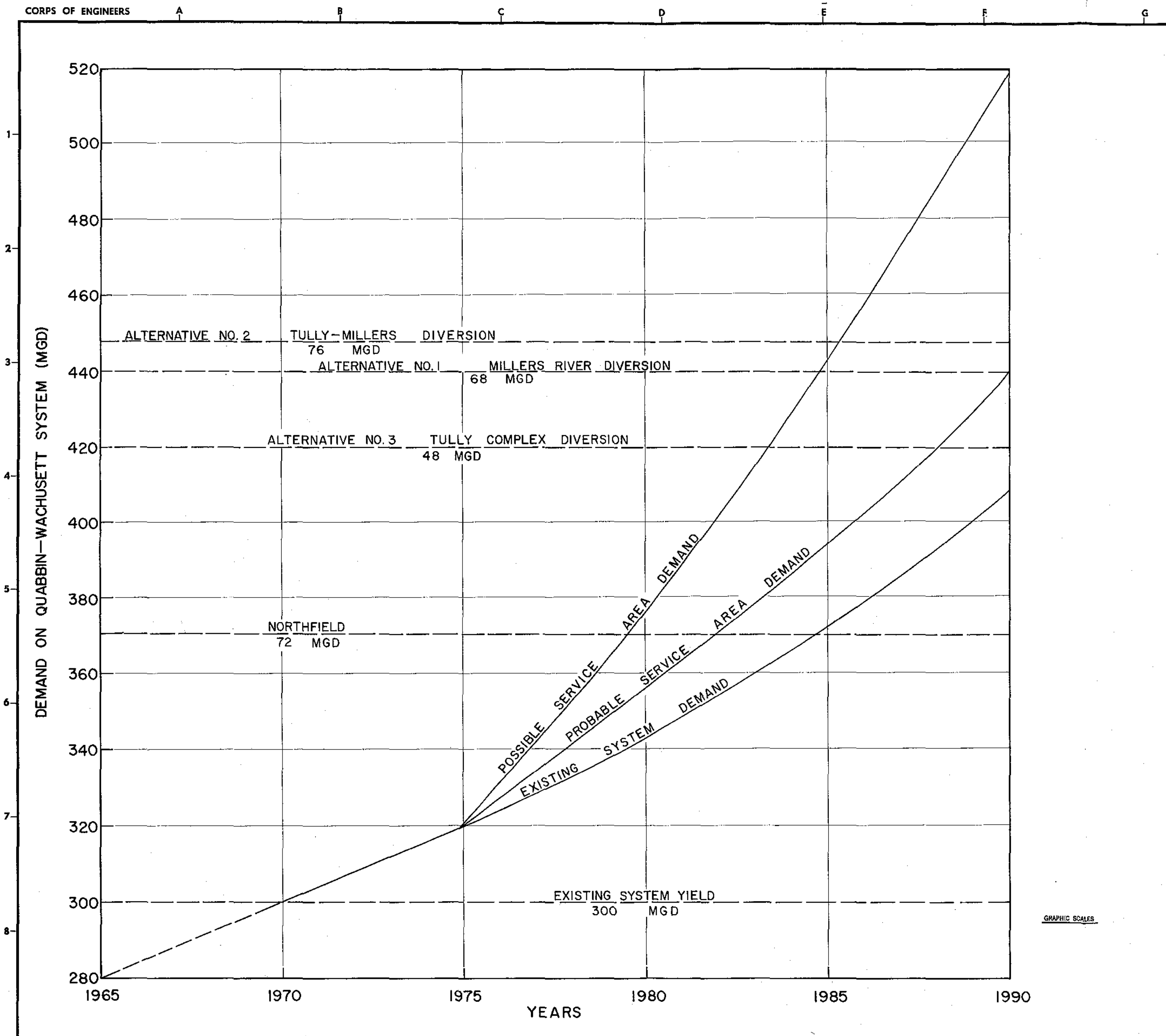



June 1969- US Army, Corps of Engineers



NORTHEASTERN UNITED STATES WATER SUPPLY STUDY
SOUTHEASTERN NEW ENGLAND
WATER SUPPLY
STUDY AREA
SCALE IN MILES
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
NORTHFIELD MOUNTAIN WATER SUPPLY PROJECT
MILLERS RIVER BASIN WATER SUPPLY PROJECT
MERRIMACK RIVER TREATMENT PLANT
PROPOSED MERRIMACK TUNNELS
EXISTING MDC SYSTEM
NEW HAMPSHIRE
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
QUABBIN RESERVOIR
WACHUSETT RES.
BOSTON
WORCESTER
SPRINGFIELD
PROVIDENCE
LOWELL
BLOCK ISLAND SOUND
N

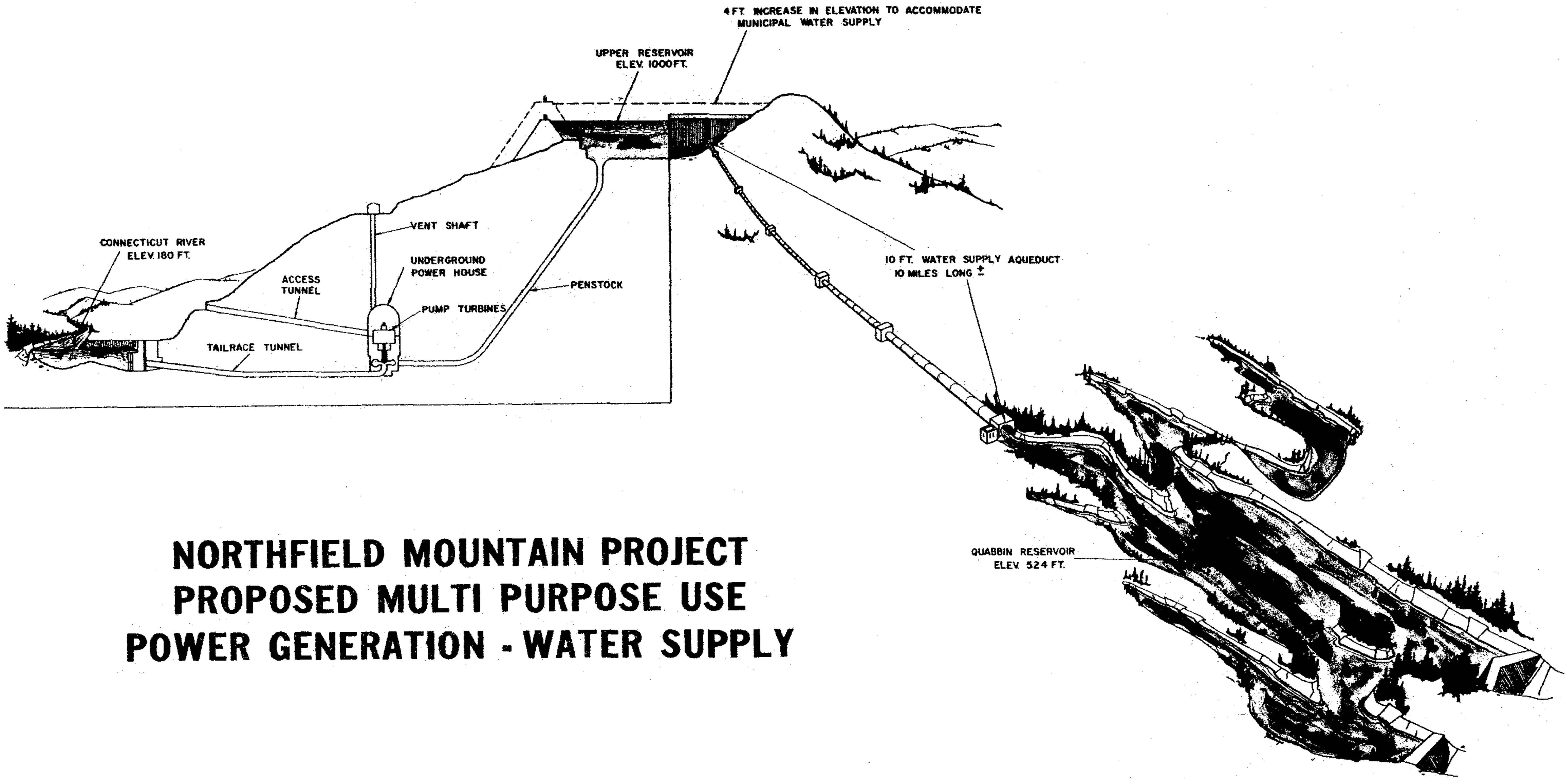

CORPS OF ENGINEERS
U. S. ARMY
FRANKLIN
HAMPSHIRE
HAMPDEN
WORCESTER
MIDDLESEX
ESSEX
SUFFOLK
NORFOLK
PLYMOUTH
BRISTOL
BARNSTABLE
10 Mi.
15 Mi.
N
LEGEND
PRESENTLY WHOLLY SUPPLIED BY M. D. C.
PRESENTLY PARTIALLY SUPPLIED BY M. D. C.
COMMUNITIES WITH NO OTHER REPORTED FEASIBLE ALTERNATIVE BUT THE Q-W SYSTEM
COMMUNITIES WITH A NUMBER OF FEASIBLE ALTERNATIVES INCLUDING THE Q-W SYSTEM
COMMUNITIES WHO CAN MEET THEIR 1990 DEMANDS FROM LOCAL SOURCES OR OTHER REGIONAL SYSTEMS
EXISTING Q-W SERVICE AREA
PROBABLE 1990 Q-W SERVICE AREA
POSSIBLE 1990 Q-W SERVICE AREA
NORTHEASTERN UNITED STATES
WATER SUPPLY STUDY
QUABBIN - WACHUSETT
WATER SUPPLY SYSTEM
EXISTING AND FUTURE SERVICE AREA
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORP OF ENGINEERS
WALTHAM, MASS.




NORTHEASTERN UNITED STATES
WATER SUPPLY STUDY

ESTIMATED DEMAND ON
QUABBIN WACHUSETT SYSTEM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORP OF ENGINEERS
WALTHAM, MASS.




# NORTHFIELD MOUNTAIN PROJECT
# PROPOSED MULTI PURPOSE USE
# POWER GENERATION - WATER SUPPLY

## PRELIMINARY

# THE WATER SUPPLY SETTING

## General

### A. Sixties Drought

As recognized in the NEWS Legislation, natural departures from normal precipitation and runoff conditions can have regional impacts on the social well-being of a large segment of the nation's population.

The long-term normal rainfall in southeastern New England is about 42 inches per year. This "normal" condition is actually the average of many high and low rainfall years. When rainfall is below average for a period of time, the area experiences a drought. The recent drought of the sixties in southeastern New England, for its duration, was the greatest ever experienced in the region based on over 200 years of rainfall record.

Because of the severity of this drought, many water supply systems were required to re-evaluate the dependable yield which their facilities could be relied on to produce. For example, the Metropolitan District Commission which, based on previous drought conditions, had estimated available sources at 330 million gallons per day (mgd) revised their dependable yield figure downward to 300 mgd.

The sixties' drought which began in 1961 when precipitation and water levels fell below normal, ultimately through its duration, directly affected the water use patterns of more than 20 million people. In 1965 alone, drought related water shortages and associated problems were severe enough to warrant emergency actions by local, state and Federal agencies. Within Massachusetts, more than 50 cities and towns imposed restrictions on water use.

### B. Water Supply Agency Action

During and following the drought, a number of communities and regional planning agencies conducted engineering studies to determine methods for augmenting their existing supplies. In many cases, new supplies have been developed by the communities which would allow them to meet future supply needs. Investigations conducted by NEWS in the southeastern New England region, however, indicate that even with the actions undertaken by local authorities, additional supplies must be made available.

It is anticipated that as water requirements increase and local water resources are fully developed, particularly in urban areas, many municipal systems will likely join some of the major systems, such as the Metropolitan District Commission (MDC) and increase the regional character of these systems. A description of the MDC system is given in the following paragraphs.

## Existing Regional System - Metropolitan District Commission - (Boston)

The Metropolitan District Commission (Boston) is the largest regional system within New England. At present, this system supplies either wholly or partially the water supply needs of 42 communities within the Commonwealth of Massachusetts. Consumers of the serviced population number about two million or fully 37 percent of the Commonwealth's 1970 population.

Existing dependable yield of the system is estimated to be 300 mgd. Average daily water consumption furnished by the system in 1971 was 322 million gallons per day (thus the system is outstripping available supply) of which 273 mgd was delivered to municipalities which rely exclusively upon the MDC as their only supply source.

The MDC relies upon surface water as its supply source. Three major reservoirs: Quabbin, Wachusett and Sudbury impound flow from tributaries of both the Connecticut and Merrimack River Basins.

The Quabbin Reservoir, located in the center of Worcester County, is the backbone of the MDC system. It impounds the runoff from 186 square miles of the Swift River Watershed and flow diverted from 98 square miles of the Ware River Watershed, both tributaries of the Connecticut River. It has a capacity of 412 billion gallons at full reservoir elevation and is approximately 18 miles long.

The water from Quabbin Reservoir flows through the Quabbin Aqueduct for a distance of 24.6 miles to the upper end of Wachusett Reservoir in West Boylston. This aqueduct, which is "horseshoe" shaped, is excavated through solid rock and line with concrete. Provisions have been made at the Ware River Intake Works at Coldbrook to divert the flood flows from approximately 98 square miles of the Ware River Watershed into the aqueduct for storage in either the Quabbin Reservoir or the Wachusett Reservoir. Under ordinary circumstances, the water is diverted directly to the Quabbin Reservoir for storage and then is drawn back into the Wachusett Reservoir as occasion requires.

The Wachusett Reservoir on the Nashua River, a tributary of the Merrimack River, above Clinton, was the principal reservoir of the MDC system prior to the construction of Quabbin Reservoir. It has a watershed of 107.7 square miles and a capacity of 65 billion gallons. It is approximately 8.4 miles long with a surface area of 6.5 square miles.

The water has two means of conveyance from Wachusett Reservoir -- the Wachusett Aqueduct and the recently completed Wachusett - Marlborough tunnel. The Wachusett Aqueduct consists of a rock tunnel section 2 miles in length, a brick and masonry conduit, "horseshoe" shaped, 7 miles in length and an open channel section of 20 feet wide at the bottom and 3 miles in length. The open channel section terminates in the Sudbury Reservoir in Southborough.

The major portion of the water supplied by the Wachusett Aqueduct is diverted at a diversion dam on the open channel section of the aqueduct in Marlborough into the Hultman Aqueduct. The remaining water flows into the Sudbury Reservoir.

The Sudbury Reservoir is situated on the north branch of the Sudbury River and impounds the runoff of approximately 22 square miles of watershed; has a storage capacity of approximately 7 billion gallons.

During summer months, large quantities of water flow from this reservoir through the Sudbury Aqueduct to the Chestnut Hill Reservoir in Brighton. From there, it is pumped into the distribution system.

The new Wachusett-Marlborough Aqueduct is a deep rock concrete lined tunnel, 8.0 miles long. It extends from the Wachusett Reservoir to the Hultman Aqueduct intake structure. The major portion of the water supply requirements of the Metropolitan Water District is delivered through this aqueduct to the Hultman Aqueduct and thence to the Norumbega and Weston distribution reservoirs.

The Hultman Aqueduct begins at the previously mentioned diversion dam located on the open channel section of the Wachusett Aqueduct. It extends from this point 22.7 miles in an easterly direction to the Chestnut Hill Reservoir and pumping stations. This aqueduct consists of cut and cover concrete conduit and a section of hardrock tunnel. At the

Sudbury Dam, it is interconnected to the Weston Aqueduct which is a cut and cover conduit extending to the low pressure service Weston Reservoir.

From an intake shaft at Norumbega, the City tunnel runs a distance of approximately 5 miles to a point in the vicinity of the Chestnut Hill Reservoir in Boston, where it is connected directly to several large distribution mains which convey the water to several of the communities serviced by the Low Service, Southern High and Southern Extra High distribution systems. The City tunnel, reduced from 12 feet to 10 feet in diameter, extends from Chestnut Hill Reservoir, a distance of approximately 7 miles, to a point in Malden, where it is connected directly into large distribution mains which convey the water to other communities serviced by the Low Service and Northern High Service distribution systems. Presently, construction of an additional deep rock tunnel, extending from Chestnut Hill Reservoir in Boston to a point in the vicinity of the Boston-Milton town line at Dorchester Lower Mills, is under way. The completed construction of this tunnel will enable the Commission to improve pressures in its Southern High Service distribution system.

The Chicopee Valley Aqueduct, consisting of 36 and 48 inch pipe, conveys water from the Quabbin Reservoir to the town of Wilbraham, South Hadley Fire District No. 1, and the city of Chicopee, extends from the outlet works of Winsor Dam to the Keating Hill Standpipe of the city of Chicopee.

Water supplied to consumers in the Metropolitan Water District is treated with small amounts of chlorine and ammonia as it enters the distribution system. Occasionally it is necessary to treat some of the storage and distribution reservoirs with small amounts of copper sulphate in order to combat algae growths which materialize from time to time. The Water Division of the Metropolitan District Commission maintains three laboratories, one at the Quabbin Reservoir, another in Framingham, and a third in Boston.

Pertinent data on the three major source reservoirs is shown in the following table:

TABLE 1

METROPOLITAN DISTRICT COMMISSION
SYSTEM SOURCES

| | Location | Drainage Area Sq. Mi. | Storage Capacity (mg) |
|---|---|---|---|
| Sudbury: | Southborough<br>Marlborough | 22.0 | 7,000 |
| Wachusett: | West Boylston<br>Sterling<br>Clinton<br>Boylston | 107.7 | 65,000 |
| Quabbin: | New Salem<br>Petersham<br>Hardwick<br>Ware<br>Belchertown | 284.8 [1] | 412,000 |
| | TOTAL | 414.5 | 484,000 |

[1] Includes 96.8 square miles of Ware River Watershed

## Local Resource Potential

### A. General

In estimating needs which might be required of the existing regional supply system (MDC), the role which locally available resources might play was investigated. The majority of new communities reported in this study as requiring connection to the regional system to meet future needs was the result of engineering studies[1] conducted by the Metropolitan Area Planning Council (MAPC). The MAPC comprises 98 municipalities in the Boston Metropolitan Region which include the majority of presently serviced MDC communities and the MDC's future short-range customers. In the following paragraphs, a brief summary of the MAPC engineering studies pertaining to local resource potential development is given.

"The purpose of this study is to identify and evaluate alternative water supply systems which may be developed to satisfy the water supply demands of the communities in the Council District through the year 1990. These systems would supplement the existing and potential local supply systems. The need for supplementing the existing supplies of most of the communities within the District was concluded from investigations conducted in conjunction with the 1969 Needs and Proposals report.

These investigations indicated that, of the 98 communities in the Council, only two communities had existing supplies capable of meeting projected 1990 demands, and only 17 communities outside of the communities served by the Metropolitan District Commission (MDC) reported potential supplies which, together with the existing supplies, could meet the 1990 demands.

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1 Inventory of Water and Sewer Facilities, May 1967, Metropolitan Area Planning Council and Massachusetts Department of Commerce and Development, by Camp, Dresser & McKee, Consulting Engineers.

Projected Needs and Current Proposals for Water and Sewer Facilities, July 1969, Metropolitan Area Planning Council, by Camp, Dresser & McKee, Consulting Engineers.

Alternative Regional Water Supply Systems for the Boston Metropolitan Area, February 1971, Metropolitan Area Planning Council, by Camp, Dresser & McKee, Consulting Engineers.

The supplemental water systems discussed were developed along criteria and design guidelines chosen to be sufficiently generalized to permit use throughout the District, yet detailed enough to produce systems which were technically sound. The efficient development of a water supply system to meet the projected demands of the communities within the Council District will require further detailed studies of the most favorable alternatives presented in this study. All systems were developed without regard to institutional constraints. Particular emphasis was placed on the development of subdistrict systems which would serve a portion of the Council District through the utilization of local resources.

Five individual subdistricts were established as follows: the Charles River Subdistrict, the Concord River Subdistrict, the Ipswich River Subdistrict, the Neponset River Subdistrict, and the North River Subdistrict.

The supplemental needs of the individual communities were determined by comparing projected demands with the estimated safe yield of the existing and potential community supplies. Needs were assessed in accordance with the study policy that all local potential supplies were to be developed.

The needs may change in time as additional potential local supplies are discovered, or potential supplies must be abandoned.

It is emphasized that all potential groundwater sources must be fully explored, and development seriously considered even though the water is of quality that will require treatment.

B. Subdistrict Water Systems

The majority of the supplies to be developed to supply the subdistrict system will be surface supplies with either on or off stream reservoirs. It is imperative that before any of these alternatives are adopted, studies be conducted to investigate fully the environmental implications of these diversions.

1) Ipswich River Subdistrict: Two of the communities listed below have adequate existing supplies to meet their projected 1990 demands. An additional six communities have potential supplies which could adequately supplement their existing supplies through 1990. However, the potential supplies in five of the communities and the existing supplies in one of the communities make use of the Ipswich River.

| | | |
|---|---|---|
| Beverly | Ipswich | Reading |
| Boxford* | Lynn | Rockport |
| Danvers | Lynnfield | Rowley* |
| Essex | Manchester | Salem |
| Georgetown* | Middleton | Topsfield |
| Gloucester | North Reading | Wenham |
| Hamilton | Peabody | Wilmington |

*Not in Council District

The Ipswich River does not have the capacity to meet these collective demands. Unless the Ipswich River is supplemented, it will be unable to supply sufficient additional yield to even the communities which now pump from it. Through the construction of three new off-stream reservoirs, together with a diversion system from the Merrimack River, the Ipswich River can be developed to adequately supplement the existing and potential supplies of the communities in the Ipswich River Subdistrict. The Merrimack River is the only possible source which would permit diversion to the Ipswich during dry periods, thus reducing the size of the off-stream reservoirs required. The longer the period of diversion, the smaller the size of the reservoirs required to produce the same yield. Under present conditions, the diversion works would be located above the City of Lowell in the Town of Tyngsborough with water being transmitted about 17.6 miles to Lubber Brook in Wilmington, a tributary of the Ipswich. If the quality of the water in the Merrimack River was upgraded, the diversion works could be moved downstream to Andover, thus decreasing the length of the raw water transmission main.

Diversions would then be made from the Ipswich River at three general locations. At the first location, diversions would be made to a proposed 1800 million gallon (mg) regional reservoir in Lynnfield and to the existing Lynn and Peabody Reservoirs. The second diversion would occur downstream off Route 1 in Topsfield and would supply the proposed 1800 mg Topsfield reservoir. This new reservoir would be operated in conjunction with the existing facilities of the Salem and Beverly Water Supply Board. The third diversion would be located in Ipswich. Water would be pumped to the proposed 2800 mg Ipswich Reservoir.

2) <u>Concord River Subdistrict:</u> None of the MAPC communities in this subdistrict will be able to adequately meet their projected 1990 demands. However, the communities in the Concord River Subdistrict

can also be supplied by the Merrimack River. This subdistrict includes four MAPC communities, Acton, Bedford, Concord and Littleton, and 13 communities adjacent to the Council District.

These communities would take their supply at the same location as the diversion works proposed for the Ipswich River Subdistrict mentioned above. The two pumping facilities may, in fact, be combined. If, however, both subdistrict systems are developed, it may be necessary to develop either additional storage facilities or a special working schedule to eliminate combined diverting during short periods of extreme low flows and thereby degrading water quality. The need will depend to a large degree on the number of the communities outside the MAPC District which would be supplied by the Concord River Subdistrict system.

3) Charles River Subdistrict: The third subdistrict considered includes the 17 communities in or adjacent to the Charles River watershed and listed below:

| | | |
|---|---|---|
| Bellingham | Milford | Walpole |
| Dover | Millis | Wayland |
| Franklin | Natick | Wellesley |
| Holliston | Norfolk | Westwood |
| Medfield | Sherborn | Wrentham |
| Medway | Sudbury | |

Five of these communities can develop potential supplies to adequately meet their projected 1990 demands. The communities in this subdistrict have been subdivided into two groups, the Upper and the Middle Charles River Groups. By developing the abundant potential local supplies of Franklin and Milford and interconnecting the individual systems, the six communities in the Upper Charles River Group can adequately meet their projected 1990 demands. The 11 communities in the Middle Charles River Group can extend the adequacy of their systems by grouping together similar to the Upper Charles River Group.

However, unless the MDC is extended to supply Sudbury, Medfield, Norfolk and Dedham, the combined 1990 demands cannot be met even if all potential supplies are developed. Following the completion of the MAPC study, the NEWS study requested the opinion of the U. S. Geological Survey (USGS) concerning the hydraulic relationship of the well field proposed for the Middle Charles River Group and the River. The USGS replied they felt the proposed well fields were directly linked to the nearby river. With such a link, the well field in essence would be drawing from river flow, particularly in low flow periods. Low flow conditions in the Charles River at present are a critical factor in the river's water quality. It was felt that any substantial decrease in flow caused by withdrawals for water supply would increase water quality problems. Thus, the NEWS study proposed communities listed as middle Charles to be served by connection to the regional system.

4) Neponset River Subdistrict: Only the town of Sharon in this subdistrict, consisting of Avon, Foxborough, Sharon and Stoughton, can develop supply adequate through 1990. The remaining three subdistrict communities will require an outside supplementing source of supply. The projected 1990 demand of the Neponset River Subdistrict can be adequately met through the development of Ponkapoag Pond as a water supply reservoir. By raising the level of the Pond some 19 feet, adequate storage capacity can be provided to receive flood flows pumped from the Neponset River. Water would be pumped from the Neponset River only during periods when the flow exceeds 25 cubic feet per second (cfs). During dry periods, pumping will be permitted only over a few months of the year. In order to provide sufficient yield, it will be necessary to provide pumping capacity greatly in excess of the estimated safe yield of the system.

5) North River Subdistrict: The fifth subdistrict system investigated would provide supplemental supply to communities located south and southeast of Boston. This North River Subdistrict includes the 15 communities located in the MAPC District, listed below, plus the communities in the Old Colony Planning Council.

| | | |
|---|---|---|
| Braintree | Holbrook | Randolph |
| Cohasset | Hull | Rockland |
| Duxbury | Marshfield | Scituate |
| Hanover | Norwell | Stoughton |
| Hingham | Pembroke | Weymouth |

Cohasset is the only member community which can develop supplies adequate through 1990. However, providing all of the communities develop their potential supplies, the North River could be developed to supply all of the communities in the subdistrict well beyond the year 1990 with the exception of the towns of Braintree, Weymouth, Randolph and Holbrook. While these communities could be supplied by the North River, it would be more realistic to supplement the supplies of these communities from the MDC, since they are remote from the North River, near the existing MDC system, and their demands would decrease the North River's period of adequacy. The only source that will be available to supplement the North River once the demands exceed its yield is the MDC, and these four communities would have to be connected to the MDC eventually.

Development of the North River for water supply purposes will require the construction of an on-stream storage reservoir located in the present tidal reach of the North River, a water treatment plant, and pumping and transmission facilities. It is recognized that an impoundment within the tidal reaches of the North River will affect the ecology of the estuary. Early estuarine studies should be made to determine the implications of ecological changes."

6) Summary: Certain groups of communities (particularly those outside Metropolitan Boston) can satisfy their present and projected 1990 needs without relying directly on the MDC. However, they cannot do so unless the MDC supplies certain key communities such as Sudbury, Medfield, Norfolk, Dedham, Braintree, Weymouth, Randolph and Holbrook. It, therefore, becomes apparent that any concept of regional supply for the eastern Massachusetts - Rhode Island Study Area depends on firming up the existing regional system, i.e. the MDC. This is the specific problem addressed by the present survey report.

Also by 1990, many communities not served by the MDC will collectively require water in addition to that available in their immediate watersheds. The development of institutions and physical systems to meet with this regional problem is critical. By 2020, the MDC will also require additional water from a large regional source. These two problems are the subjects of on-going studies.

## Expected Expansion of the Regional System Service Area

Because potential new water supply sources within the Eastern Massachusetts area are rapidly becoming exhausted, communities are forced to look to regional concepts in water resource development as a means of meeting their future water supply needs. The MDC system represents the largest system in Massachusetts, and for this reason is expected to be called upon to expand its service area considerably by the year 1990.

Under present Massachusetts state Legislation, the MDC system is required to permit any municipality within 10 miles of the State House in Boston to become a member upon application. The MDC is further bound by the same legislation to allow any other municipality within 15 miles of the State House which could be reasonably serviced by the MDC to become, upon application, a member. Any non-member municipality with the approval of the Massachusetts Department of Public Health can be furnished water by the MDC.

In an attempt to determine what communities might be serviced by the regional system in 1990, four groups of municipalities were identified.

1) Cities and towns presently serviced by the MDC.

2) Municipalities who cannot meet their future demands from local sources and who have no other reported feasible alternative but to join the MDC system.

3) Communities with a number of reported feasible alternatives including joining the MDC system.

4) Those cities and towns who can meet their future demands from local sources or from other regional systems not including the MDC system.

The MDC system presently is made up of 32 member communities, 25 of which are wholly served. The MDC also supplies water to 10 non-member communities which draw from either the Chicopee Aqueduct in the Springfield area or from the Wachusett-Sudbury reservoir system. These cities and towns, listed in Table 2, obtain water from the MDC because there simply are no other feasible sources of water supply available to them. Therefore, with the exception of Peabody, it has been assumed that all additional future water demands originating from these communities will be met completely by the MDC system. Peabody's additional demand may be met by further development of the Ipswich River.

The remaining communities in the study area were then investigated to determine if they can meet their 1990 water demand locally and then, if not, whether it is feasible for them to join the MDC system. The communities listed in Table 10 have no other reported feasible alternative to meet their additional future water demands other than joining the MDC system. Because they all can be reasonably served by the MDC, these cities and towns are included in the potential 1990 service area.

The third category of communities are listed in Table 4. These cities and towns have a number of feasible alternatives including connection to the MDC system. Other alternatives available to the municipalities include development of the Merrimack, Ipswich and North Rivers as well as ground water resources in some cases.

Those communities not anticipated to join the MDC system by 1990 are shown on Table 4. Based on a review of these municipalities' 1990 water supply needs, it appears adequate local resource is available or entrance to another regional system is a more feasible solution.

The 1990 water demands on the Quabbin - Wachusett Reservoirs (MDC system) were then estimated for the three groups of communities which may be serviced. Supply demand estimates, as described in Table 4, were derived using both population and industrial output forecasts. Population increases were combined with estimates of future per capita usage to provide supply needs domestic, commercial and public usage. Industrial output forecasts using a water use per dollar output analysis allowed the estimation of supply needs for heavy water using industry. Both estimates were then combined to give total future water requirements.

Once the supply requirements were established, the additional development necessary to meet these needs was determined. This was accomplished by subtracting safe yields of existing and anticipated supply sources from the total estimated needs. Using this methodology, the existing MDC's service area 1990 water demand was estimated to be about 410 million gallons per day (mgd). If the cities and towns with no other reported alternative were to join the MDC, total demand for 1990 was estimated to be about 441 mgd. If all communities noted as including the MDC as an alternative source were serviced, then 519 mgd would be needed in 1990.

Based on the investigations conducted in this report then the 1990 water supply needs to be met by the MDC could vary from a minimum of 410 mgd to a possible maximum of about 519 mgd. Although it is possible that all communities described as having other potential sources may elect to join the MDC system, it is unlikely. Based on efforts observed by this group, it appears that certain communities are willing and planning to develop the local resource to meet their needs. Providing additional supplies to non-MDC communities is part of the problem addressed by on-going NEWS studies. In this report, 1990 demands on the regional system estimated for presently served communities and those with no other reported option were used for planning purposes.

## TABLE 2

## COMMUNITIES PRESENTLY BEING SERVICED BY THE M.D.C.

FULLY SUPPLIED MEMBERS:

| | | |
|---|---|---|
| Arlington | Malden | Quincy |
| Belmont | Marblehead | Revere |
| Boston | Medford | Saugus |
| Brookline | Melrose | Somerville |
| Chelsea | Milton | Stoneham |
| Everett | Nahant | Swampscott |
| Lexington | Newton | Waltham |
| Lynnfield Water District | Norwood | Watertown |
| | | Winthrop |

PARTIALLY SUPPLIED MEMBERS:

| | |
|---|---|
| Cambridge | Peabody |
| Canton | Wakefield |
| Needham | Weston |
| | Winchester |

NON-MEMBERS SUPPLIED:

| | | |
|---|---|---|
| Clinton | Leominster | Southborough |
| Chicopee | Marlborough | South Hadley, F.D. #1 |
| Framingham | Northborough | Wilbraham |
| | | Worcester [1] |

| | |
|---|---|
| Total Estimated 1990 Demand | 450 MGD |
| 1965 Safe Yield [2] | 335 MGD |
| Anticipated Expansion of Local Sources | 5 MGD |
| 1990 Deficit | 110 MGD |

[1] On an emergency basis only.

[2] Includes 300 MGD Safe Yield of Quabbin-Wachusett System.

TABLE 3

COMMUNITIES WITH NO OTHER REPORTED OPTION

| | |
|---|---|
| Ashland | Millis |
| Avon | Natick |
| Bolton | Norfolk |
| Braintree | Randolph |
| Dedham | Sherborn |
| Dover | Stoughton |
| Holbrook | Stow |
| Holliston | Sudbury |
| Hudson | Wellesley |
| Lincoln | Westwood |
| Maynard | Weymouth |
| Medfield | Woburn |

| | |
|---|---|
| Total Estimated 1990 Demand | 74 MGD |
| 1965 Safe Yield | 39 MGD |
| Potential Local Sources | 4 MGD |
| 1990 Deficit | 31 MGD |

TABLE 4

COMMUNITIES WITH OTHER OPTIONS INCLUDING THE M.D.C. SYSTEM

IPSWICH RIVER:

| | | |
|---|---|---|
| Beverly | Ipswich | Peabody |
| Danvers | Lynn | Reading |
| Essex | Lynnfield | Rockport |
| Gloucester | Middleton | Salem |
| Hamilton | North Reading | Topsfield |
| | | Wilmington |

| | |
|---|---|
| Estimated 1990 Demand | 58 MGD |
| 1965 Safe Yield | 47 MGD |
| 1990 Deficit | 11 MGD |

CONCORD RIVER:

| | |
|---|---|
| Acton | Concord |
| Bedford | Littleton |

| | |
|---|---|
| Estimated 1990 Demand | 12 MGD |
| 1965 Safe Yield | 5 MGD |
| 1990 Deficit | 7 MGD |

MERRIMACK RIVER:

| | |
|---|---|
| Billerica | Dracut |
| Chelmsford | Tewksbury |
| | Tyngsborough |

| | |
|---|---|
| Estimated 1990 Demand | 22 MGD |
| 1965 Safe Yield | 12 MGD |
| 1990 Deficit | 10 MGD |

TABLE 4 (cont'd)

NORTH RIVER:

| | | |
|---|---|---|
| Abington | Hanson | Pembroke |
| Brockton | Hingham | Rockland |
| Duxbury | Hull | Scituate |
| Halifax | Marshfield | Whitman |
| Hanover | Norwell | |

| | |
|---|---|
| Estimated 1990 Demand | 39 MGD |
| 1965 Safe Yield | 28 MGD |
| 1990 Deficit | 11 MGD |

CHARLES RIVER:

| | |
|---|---|
| Bellingham | Medway |
| Foxborough | Wrentham |

| | |
|---|---|
| Estimated 1990 Demand | 9 MGD |
| 1965 Safe Yield | 5 MGD |
| 1990 Deficit | 4 MGD |

MILL RIVER:

| | |
|---|---|
| Hopedale | Mendon |
| Hopkington | Milford |

| | |
|---|---|
| Estimated 1990 Demand | 6 MGD |
| 1965 Safe Yield | 2 MGD |
| 1990 Deficit | 4 MGD |

TABLE 4 (cont'd)

WORCESTER AREA:

| | | |
|---|---|---|
| Auburn | Holden | Princeton |
| Berlin | Leicester | Shrewsbury |
| Boylston | Millbury | West Boylston |
| Grafton | Paxton | Worcester |

| | |
|---|---|
| Estimated 1990 Demand | 47 MGD |
| 1965 Safe Yield | 26 MGD |
| 1990 Deficit | 21 MGD |

COLLEGE AREA:

| | |
|---|---|
| Amherst | Hadley |
| Belchertown | Pelham |
| Granby | South Hadley, F. D. #2 |

| | |
|---|---|
| Estimated 1990 Demand | 10 MGD |
| 1965 Safe Yield | 4 MGD |
| 1990 Deficit | 6 MGD |

WEST SPRINGFIELD:

| | |
|---|---|
| Estimated 1990 Demand | 7 MGD |
| 1965 Safe Yield | 3 MGD |
| 1990 Deficit | 4 MGD |

| | |
|---|---|
| TOTAL ESTIMATED 1990 DEMAND | 210 MGD |
| TOTAL 1965 SAFE YIELD | 132 MGD |
| TOTAL 1990 DEFICIT[1] | 78 MGD |

[1] Deficit shown is expected to be met by local resource development.

## Capability of System to Meet Future Needs

### A. Source

The estimated yield from the existing MDC sources of supply is about 300 mgd. In 1971, the average daily demand of all communities serviced by the system was about 322 mgd. At present then, withdrawals from the system exceed the available dependable yield. The most striking example of this demand in excess of supply situation is at Quabbin Reservoir, the main storage facility of the system. From a low pool elevation of 495 feet (full pool 530 feet) the reservoir has been unable to replenish its storage.

Forecast demands on the system for 1990 indicate an additional increment of 141 mgd of yield will be necessary unless water use practices of the serviced population are altered dramatically.

The MDC as a result of their analysis have reported to the Massachusetts State Legislature the next step in providing the supply necessary to meet future needs is the diversion via the Northfield Mountain [1] Project. At a NEWS meeting held in Boston, Massachusetts, in May 1970, local, State and Federal officials agreed that the Northfield Mountain Project was a viable element in any regional water supply plan.

If the yield from Northfield Mountain is made available, the total dependable yield available to the system would be about 372 mgd. Based on the forecast demands, this project would meet supply needs to about 1984. In order to meet the short-range 1990 needs then an additional source of supply will be needed.

In the report, the potential of diverting water from the Millers River Basin, a tributary of the Connecticut, is being investigated. Depending on the method of development employed, this source could produce from 48 to 76 mgd of additional supply.

Development of the Millers River Basin Project as described in the report then could add about 25 percent to the existing system yield. This addition, when combined with the Northfield Mountain yield, would allow adequate supplies within the serviced communities to about 1990.

### B. Transmission Facilities

Although the intent of this Interim Report of Survey was to investigate new sources of supply to meet future needs, a preliminary analysis of the MDC's transmission facility was also conducted. The purpose of

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[1] Subject of a companion NEWS report.

evaluating the transmission facilities was not to include any needed improvements as recommendations for authorization, but rather to present a full picture of the system's present capability.

In order to determine the adequacy of the major transmission aqueducts, the peak demands for the system had to be estimated. Variations in water demands due to seasonal weather changes have always been important considerations in the design of water supply systems in the northeastern United States and particularly in New England. Historically, summer periods have promoted exceptionally high water demands which quite often last for several weeks. In most cases, these peak demands must be met by the water supply storage reservoirs, since storage within the distribution system itself cannot usually be economically constructed to handle these peak loads.

The ratio of the maximum day demand to the average daily demand is directly related to the type and character of the development within the community or communities to be served. The present MDC system, as described earlier, services 32 member communities within the greater Boston area. Twenty-five of the communities depend wholly upon the system to supply their water needs, while the remaining seven communities make maximum use of their own sources and only rely upon the MDC system to supply their peak demands. The 25 wholly supplied communities range from completely residential in character to the inner core cities with industrial and commercial development. During the recent drought of the 60's, the ratio of the maximum day demand to the average daily demand for the city of Boston reached a high of 1.24, while the ratio for the total 25 communities reached 1.65. This difference has been attributed to the effect of the suburban communities peak demands upon the system. If the MDC is called on to expand its service area, it will be adding suburban communities which are largely residential in nature. Thus, the maximum daily demand ratio can be expected to increase above the present high figure of 1.65. The amount of increase will, of course, depend on what portion of the total water demand upon the system the new members demand represents.

To determine what increase, if any, the transmission facilities would have to supply by 1990, peak demand characteristics of a number of eastern Massachusetts communities were examined. Based on this investigation, it appeared a maximum day ratio of 1.70 to average daily demand represented a reasonable value for planning purposes. A comparison of this figure to other historic and projected maximum day data for large metropolitan systems in the Northeastern United States was then made and proved to be comparable.

Applying the maximum day ratio to demands forecast in the Boston Metropolitan area, it appears the present transmission facilities from Wachusett Reservoir to the Boston City tunnel system may be inadequate. This inadequacy can be primarily attributed to the limiting carrying capacity of the Hultman Aqueduct.

At present, the Metropolitan District Commission has under way a large scale (one million dollar) investigation of its water supply system. Included in this investigation will be an examination of the future courses of action which the MDC may pursue with regard to supply, demand and conveyance facilities. One of the major study elements will be the adequacy of the system's aqueducts. The results of this investigation will describe problem areas and corrective actions needed.

1. Project Description. Possible water supply diversion proposals under consideration and included in this Environmental Impact Statement are:

A. Diversion of Connecticut River water through the Northfield Mountain pumped storage project into Quabbin Reservoir.

B. Diversion of flow from the East Branch Tully and Millers Rivers into Quabbin Reservoir.

No known National Register properties would be affected by the projects.

## NORTHFIELD MOUNTAIN WATER SUPPLY PROJECT

Authorization for construction of the diversion facilities from Northfield Mountain to Quabbin Reservoir has been granted to the Metropolitan District Commission by the Massachusetts State Legislature. Recognizing this fact, the representatives of the Federal, State and local agencies and interests at the May 1970 meeting recommended that the Corps of Engineers investigate the project as a very viable element in any regional water supply plan for Southeastern New England. It was further recommended that the NEWS studies be designed to complement those under way, or planned by the Metropolitan District Commission.

The Northfield Mountain Diversion project as in the Millers River Basin Alternatives would use a high flow skimming technique; that is, flow would be diverted during high flow periods, principally during spring run-off periods. As a means of control, diversions would not occur if flow in the Connecticut River at Montague City U. S. Geological Survey gaging station is less than 17,000 cubic feet per second or about 11,000 million gallons per day. This control flow is specified in the current Massachusetts State Legislation regarding the Northfield Mountain project.

### Description of the Facilities

In this project, water would be diverted from the Connecticut River through the Northfield Mountain pumped storage hydroelectric facility located in Northfield and Erving, Massachusetts.

The pumped storage project for electricity generation consists of a high level storage reservoir on Northfield Mountain, underground pump-turbine facilities and low level storage in the Turners Falls pool. The high level reservoir consists of a system of dams and spillways to provide 17,000 acre-feet of storage about 800 feet above the Turners Falls pool on the Connecticut River.

In order to provide the water supply diversion volume, the electric utility would pump an additional 375 million gallons each day that control flows in the Connecticut River would allow. The additional yield which could be made available by this plan would be 84 million gallons per day on a long term average annual basis. Because of operational considerations, such as water quality testing, analysis, etc., however, the yield estimated to be made available to Quabbin Reservoir is about 72 million gallons per day.

In order to incorporate the water supply diversion into the Northfield Mountain Project, three modifications to the pumped storage facilities are necessary. These are:

1) Raising the upper reservoir located on Northfield Mountain about 4 feet to provide about 50,000,000 cubic feet of additional storage capacity.

2) Provision of head works at the upper reservoir for the diversion aqueduct to Quabbin Reservoir.

3) About 9.8 miles of connecting aqueduct and outlet facilities at Quabbin Reservoir.

The first two items necessary for diversion have been essentially completely constructed at the upper reservoir on Northfield Mountain by the electric utility construction forces. A plan of these facilities is shown in the attachment.

The third item necessary for water supply diversion is presently in preliminary design stages by engineers at the MDC. At present, plans indicate water would be diverted from the upper reservoir through an eight-foot diameter steel pipe constructed in the east dike of the Northfield Mountain upper reservoir. Water would be withdrawn at an average rate of 375 million gallons per day and delivered to an intake shaft of the Northfield - Quabbin tunnel aqueduct.

The intake down shaft would be a scroll type configuration with a diameter of 16 to 18 feet. Water would be conveyed from a maximum upper reservoir pool elevation of 1004 feet msl in this vertical shaft to the aqueduct at elevation 300 feet msl.

The aqueduct would be a 10-foot finished diameter tunnel with a reinforced concrete liner. From the downtake shaft, the aqueduct would run about 0.5 miles to the vicinity of the south bank of the Millers River. At the Millers, a 10-foot diameter construction shaft would be excavated.

Continuing to Quabbin, the aqueduct would be driven about 3.0 miles to the vicinity of Bullard Hill. In this tunnel reach, the aqueduct would rise from the 300' elevation at the Millers River to elevation 440'. A second construction shaft would be provided at this location.

From Shaft No. 3, the tunnel would continue about 6.2 miles to the uptake shaft located in Rattlesnake Hill adjacent to Quabbin Reservoir. At Rattlesnake Hill, an uptake shaft would be driven from elevation 440 to elevation 500. At elevation 500, the tunnel would be enlarged from ten to 30 feet in width in a 150 foot long transition zone. Flow entering Quabbin from the transition zone would be conveyed in a 30-foot wide channel cut to the main channel of the Middle Branch of the Swift River.

Cost estimates for the water supply element of the project, including the raising of the upper reservoir, intake works, connecting tunnel aqueduct to Quabbin Reservoir and outlet works, would total about 40 million dollars.

Preliminary estimates of land needed for this project total about 30 acres. Land requirements for this plan may also involve about 5 acres for disposal of rock excavated from the tunnel. The firm requirement for these lands, however, would be determined during detailed design.

A major element considered in the evaluation of this project was the impact which the diversion could have on the environmental health of Quabbin Reservoir. A description of these possible impacts is included in Section 3.

## MILLERS RIVER BASIN WATER SUPPLY PROJECT

Three alternatives were developed all within the Millers River Basin to meet the water demands of the expanded regional system. The first is diversion directly from the Millers River above Athol to Quabbin Reservoir. This diversion would result in an average annual yield of 68 mgd and would require advanced treatment of the point sources of pollution on the Millers River, upstream of the diversion site. The second alternative is a combination of one and three. Water would be diverted only from the East Branch Tully River and from the Millers River above Athol, resulting in an average annual yield of 76 mgd. As in the first alternative, advance waste treatment of the pollution sources would be required; but because Tully Lake would not be used for water supply storage, the reservoir would not have to be stripped. Alternative three is the Tully Complex - a series of small diversion works on four tributaries of the Millers River. An average annual yield of 48 mgd is expected with no treatment required before entering Quabbin Reservoir.

On the basis of the investigations conducted, Alternative No. 2 is the preferred plan and is the project described in the following paragraphs. Alternative Nos. 1 and 3 are described in Section 5 - Alternatives to the Proposed Action.

In this plan, diversion from the Millers River Basin would be accomplished via withdrawals from the East Branch Tully River and the mainstem of the Millers River above Athol, Massachusetts. Facilities necessary for development would include a morning glory type inlet structure just downstream from the existing Tully flood control reservoir and an 8-foot diameter tunnel to the Millers River above Athol. At the Millers River, a second tunnel inlet would be constructed, connected to the Tully aqueduct, and from this location, a 10-foot tunnel would be driven to Quabbin Reservoir where water would be discharged through an outlet structure. Waste treatment plants on six point sources of pollution would also be required. The plate titled Tully - Millers Diversion - Alternative No. 2 shows the location of the proposed structures.

The Tully diversion site for this alternative is located at the existing Corps of Engineers flood control reservoir on the East Branch Tully River. However, no storage would be used for water supply within the flood control reservoir. The site is located about 4 miles upstream from the confluence of the Tully River and Millers River in Athol. The structure would consist of an inlet to the 8-foot diameter tunnel to the Millers River above Athol and an 8-foot high bascule gate attached to the existing Tully Lake outlet channel.

The existing outlet channel of Tully Lake would be enlarged to 30 feet wide for a distance of 1200 feet. A 30-foot long, eight-foot high gate would regulate the water height and velocity in the outlet channel. During diversion, the bascule gate and the three 8 x 8 foot gates would be raised creating a stilling pool and increasing the water level above the lip of the tunnel inlet. The 22-foot morning glory drop inlet would be located adjacent to the outlet channel in the middle of a 60-foot square chamber cut in rock. The three 8 x 8 foot gates to the inlet chamber would be opened only when diversions were occurring. By regulating these four gates and the gates at the existing dam, various combination of diversion flows and downstream flows can be achieved.

Water entering the morning glory inlet would drop down the vertical eight-foot shaft into the tunnel. The eight-foot diameter tunnel would cover a distance of 2.5 miles from the outlet of Tully Lake to a point upstream of Athol on the mainstem of the Millers River where it would then feed into the Millers-Quabbin leg of the aqueduct. The tunnel would be excavated by mole methods and concrete lined to a finished diameter of eight feet.

The Millers River diversion site would be located on the Millers River about three miles upstream from the confluence of the Tully and Millers Rivers in Athol, Massachusetts. The structure located in Athol would consist of an inlet to the 10-foot diameter tunnel to Quabbin Reservoir controlled by a combination weir-bascule gate extending across the Millers River. The concrete control structure, 120 feet long, would provide a regulated pool for the inlet shaft. The bascule gate, 70 feet long and 5 feet high, would regulate the water height and velocity to the inlet. During diversion, the bascule gate would be raised creating a stilling pond and increasing the water level above the elevation of the inlet structure weir. The 22-foot diameter morning glory inlet tapering to the 10-foot diameter inlet shaft would be located on the northern bank in the center of a 60-foot square chamber cut in rock. The three 8 x 8 foot gates to the inlet chamber would be opened only when diversions were occurring. By regulating these gates in conjunction with the bascule gates, various combinations of diversion flows and downstream flows can be achieved.

Water diverted from the river would enter the morning glory inlet and drop down the 10-foot diameter vertical shaft into the tunnel and join the Tully River water. The 10-foot diameter tunnel would run a distance of 7 miles from the Millers River inlet to a point south of Gays Hill on Quabbin Reservoir. The tunnel would be excavated in rock by mole methods and lined with concrete to a finished diameter of ten feet. Both the inlet and outlet shafts would be used as construction shafts. The outlet at Quabbin Reservoir would consist of an inclosed transition structure, a concrete stilling basin and a 20-foot wide trapezoidal channel leading to the Middle Branch of the Swift River in Quabbin Reservoir. The structure would be founded on bedrock and includes a wet well with two 8 x 8 foot gated passageways and a control building. The stilling basin would reduce velocities to a reasonable level if Quabbin Reservoir was below elevation 503 msl; but if the pool was higher, discharge would be directly into the pool. The riprapped channel would extend from the stilling basin some 800 feet across a swampy area to the original Middle Branch of the Swift River channel. This channel makes its way to Windsor Dam and the Quabbin - Wachusett tunnel inlet.

An analysis was made of the present and projected loadings of waste discharges upstream from the diversion intake, present and planned treatment, and present and planned waste effluents. Based on available information, further treatment beyond that presently planned would be required to insure a good quality water for diversion. Our studies indicate that tertiary treatment at the source of pollution is preferred to water treatment at the Millers River intake. The final determination of this additional treatment will be made during the Design Phase. By that time, the planned secondary treatment plants will probably be in operation and the effectiveness of these plants will be known. Also, then, the effect the existing sludge banks will have on the water quality can be measured. It is expected that once the load on the river is minimized, the natural flushing action will wash away large amounts of sludge in the Millers and Otter Rivers resulting in a relative stable water quality.

The operation of this diversion would depend first on the flow in the Connecticut River as measured at the U. S. G. S. gaging station at Montague City, Massachusetts; and secondly, on the flow in the rivers at the two diversion sites. On any given day, the flow in the Connecticut River at Montague City would be checked to see if the flow is above 17,000 cfs. If it is not, then no diversion would occur no matter what the flow in the Millers or Tully Rivers is. If the flow in the Millers River at the diversion site is less than the flow determined to be required for the river and its environment, then no diversion from the Millers River would occur. This required flow, referred to as the control flow, which is an estimate, not permanently set and may have to be adjusted upon project implementation, was determined from flow requirements for assimilation of wastes; for fish and wildlife, and is related to the time of year and the drainage area.

TABLE 5

MILLERS RIVER CONTROL FLOW AT INTAKE

| | Jan Feb Mar | Apr May Jun | Jul | Aug | Sep Oct Nov | Dec |
|---|---|---|---|---|---|---|
| CSM | 0.5 | 1.25 | 2.0 | 1.0 | 0.75 | 0.5 |
| CFS | 100 | 250 | 400 | 200 | 150 | 100 |

If the Connecticut River flow is above 17,000 cfs and the Millers River flow is above the control flow for that day, then diversion from the Millers River would occur. In no case would water be diverted lowering the flow in the river below the control flow. But, neither would the flow be augmented when it was naturally below the control flow. So, the rate of diversion on any given day could vary from zero to the maximum capacity of the tunnel, 730 cfs.

The same procedure would apply for diversion of East Branch Tully River water, except the control flows and the maximum diversion rate would be less. The control flows at the East Branch Tully River intake are as follows:

TABLE 6

EAST BRANCH TULLY RIVER CONTROL FLOW AT INTAKE

| | Jan Feb Mar | Apr May Jun | Jul | Aug | Sep Oct Nov | Dec |
|---|---|---|---|---|---|---|
| CSM | 0.5 | 1.25 | 2.0 | 1.0 | 0.75 | 0.5 |
| CFS | 25 | 63 | 100 | 50 | 38 | 25 |

If the Connecticut River is above 17,000 cfs and the East Branch Tully flow is above the control flow for that given day, then diversion from the East Branch Tully River would occur. The rate of diversion on any given day could vary from near zero to 490 cfs, the maximum capacity of the tunnel.

The flow rates in the Connecticut, Millers and East Branch Tully Rivers would be automatically fed into the control centers at the Tully and

Millers River intakes. Also, water quality readings would be read from the monitoring station upstream of the Millers River diversion site and samples in the Tully River. This information would then be used to determine if the diversions would occur and if so, at what rates. Diversions might occur at both sites simultaneously or possibly only at one site depending on the river flows and water quality. The bascule gates and inlet gates at each diversion site would be regulated in such a manner as to divert the maximum total amount of water to Quabbin Reservoir. The entire operation would essentially be controlled from the Millers River intake.

The total project cost, including advanced waste treatment facilities, is estimated to be 41 million dollars based on May 1972 price levels. All costs include an allowance for contingencies, engineering and design, and supervision and administration. The estimated costs are based on knowledge of the site and experience on similar projects. Evaluations of property are based on real estate studies and information from local officials reflecting values in recent sales in the area. Average annual costs are based on an interest rate of 5-1/2 percent. The project is amortized over a 50 year economic life. Allowances for maintenance, operation and replacement of equipment have been included in the annual charges.

Multi-purpose applications of this project were also investigated. The Millers River would be returned to its previous excellent quality offering numerous recreation opportunities. Additional incidental flood control benefits would occur because higher discharges from Tully Dam would be possible, knowing that a maximum of 490 cfs would be diverted to Quabbin Reservoir. However, this would reduce the amount of water diverted from the Millers River because the maximum capacity of the 10-foot section of tunnel is 730 cfs. During times of potential flooding, coordination would be maintained between Tully and Birch Hill Dams and the two diversion sites to insure the proper operation for flood control. Still, the economic benefits for flood control protection attributable to this alternative are minimal, primarily because of the flood protection given by the existing dams.

The existing "Master Plan for Reservoir Development" of Tully Dam could remain essentially the same. Present considerations are for the development of a canoe and hiking reserve and a primitive camping area. Sanitary facilities would be designed to meet Massachusetts Department of Public Health Standards for water supply streams. Also, no diversions from Tully would occur during the recreation season. This would insure the protection of Quabbin Reservoir.

The present available data on the water quality and the quality of the bottom deposits are incomplete from a design viewpoint. Further sampling will be required to design the treatment systems and to determine resultant water quality after treatment of point sources. But after the plants are in operation and the river has stabilized, a permanent monitoring station would be required upstream of the Millers River diversion site. Measurements would be taken on a number of water quality parameters to insure that the water to be diverted is acceptable.

On the East Branch Tully River, no further water quality testing on a scheduled basis would be required. Samples would be taken on an intermittent basis (four or five times during the diversion period). If anything showed up in these samples, then a sanitary survey would be performed to isolate the problem.

The water quality of Quabbin Reservoir is also of major importance. So sampling station would be set up within the Middle Branch of Quabbin Reservoir. Similar tests would be run on these samples, as on the Millers River samples. If discharges are also made into the West Branch of Quabbin Reservoir, then other sampling stations would be set up.

## 2. Environmental Setting Without the Project

### General Geology

Glaciation has modified the topography of the region by smoothing the hills and ridges, steepening some slopes and filling the valley bottoms. It is a region of long, broad ridges and rolling hills which rise in fairly steep but generally smooth and regular slopes above the relatively wide valleys. Till forms a generally thin mantle over the bedrock on the hills and occurs as thick filling in the valley bottoms under extensive outwash deposits which form wide, flat flood plains and prominent terraces on the valley walls. Locally, the valleys are constricted by rough and irregular kame deposits consisting of outwash and modified till. The bedrock of the region consists of a series of closely folded Carboniferous rocks, mainly schist and gneiss with large areas of granite and pegmatite. The folds trend generally north - south.

### Geology of the Connecticut River at the Confluence of the Millers River

The following account is based on The Flow of Time in the Connecticut Valley: Geological Imprints, by George W. Bain and Howard A. Meyerhoff, The Connecticut Valley Historical Museum, Springfield, Massachusetts, 1963:

The drainage system of the older Connecticut Valley was buried in glacial times by the deposits of Lake Hadley. The river's present course was established on these lake sediments and the inner valley is excavated in them. Prior to post-glacial entrenchment, the southerly flowing reach of the river above the Millers River confluence was deflected westward across the lake plain by the delta of the Millers River. It turned southward again where it met the traprock ridge below the present location of Turners Falls. The Turners Falls Dam now marks the spot where the Connecticut River poured over the banks of the glacial lake and into the channel of its pre-glacial tributary, Falls River. The deep gash in the Triassic rocks here was formed by the falls receding upstream during the post-glacial age.

Above the confluence of the Millers River, the Connecticut River occupies a narrow rock gorge for about a mile northward, above which point the valley widens out. This section of the river's course as far north as Northfield was formed in the bed of glacial Lake Hadley. After washing away the loose deposits of the lake bed, the river channel encountered a weak contact zone between Triassic conglomerates on the west bank and the metamorphic rocks of the higher ground to the east. The river deepened the channel in the contact zone thereby creating the scenic stretches now dominated by French King Bridge.

The composition of the river bottom in Massachusetts varies from rock, rubble, gravel and sand to mud, silt and clay. The majority of the exposed areas during low water stages are sand or gravel deposits.

Connecticut River Basin

The Connecticut River from its origin flows south for approximately 404 miles, the lower 60 of which are tidal, and drains an area of 11,265 square miles before emptying into Long Island Sound. The river flows through wilderness areas as well as highly populated urban communities such as Holyoke and Springfield, Massachusetts, and Hartford, Connecticut. Sixteen dams have been erected along the mainstem of the river, primarily to provide hydroelectric power.

The river supports industry, navigation, recreation, sport and commercial fisheries, as well as provides a domestic water supply to a number of communities in and outside the basin.

Historically, the Connecticut River has supported major runs of anadromous fishes including American shad, alewives, blueback herring, rainbow smelt, sturgeon, and Atlantic salmon. Though the first four of these species still complete their annual migrations for spawning within the lower reach, all were eliminated from the upper portion subsequent to dam construction. The Atlantic salmon has been entirely eliminated. A sport fishery does exist throughout the river's length; however, it reaches peak importance along the tributaries, largely through annual stockings of trout to maintain a "put-and-take" sport fishery. Efforts are being expended to restore anadromous fish to the entire watershed through construction of fish passage facilities at obstructions not having these and operation of salmon hatcheries. Pollution abatement programs to comply with State standards should lead to restoration of high quality aquatic resources and their utilization. The Environmental Protection Agency's pollution abatement schedule for the Connecticut River sets 1976 as completion date for pollution control facilities.

The proposed diversion site at Northfield Mountain is located with a soon to be completed pumped storage hydroelectric facility. The pumps would be used during the non-generating period for the transfer of water from the Connecticut River via tunnel to Quabbin Reservoir during the spring run-off period. Anadromous fish species are not now found in this portion of the river; however, 23 resident species have been collected within this reach according to the list on the following page.

FISHES COLLECTED IN THE CONNECTICUT RIVER,
TURNERS FALLS TO VERNON DAM, 1970-1971.

| | |
|---|---|
| American eel | *Anguilla rostrata* |
| Brook trout | *Salvelinus fontinalis* |
| Brown trout | *Salmo trutta* |
| Chain pickerel | *Esox niger* |
| Carp | *Cyprinus carpio* |
| Fallfish | *Semotilus corporalis* |
| Golden shiner | *Notemigonus crysoleucas* |
| Common shiner | *Notropis cornutus* |
| Spottail shiner | *Notropis hudsonius* |
| White sucker | *Catostomus commersoni* |
| Brown bullhead | *Ictalurus nebulosus* |
| Yellow bullhead | *Ictalurus natalis* |
| Banded killifish | *Fundulus diaphanus* |
| White perch | *Morone americana* |
| Largemouth bass | *Micropterus salmoides* |
| Smallmouth bass | *Micropterus dolomieui* |
| Pumpkinseed | *Lepomis gibbosus* |
| Bluegill | *Lepomis macrochirus* |
| Black crappie | *Pomoxis nigromacultatus* |
| Rock bass | *Ambloplites rupestris* |
| Yellow perch | *Perca flavescens* |
| Walleye | *Stizostedion vitreum vitreum* |
| Tesselated darter | *Etheostoma olmstedi* |

Existing water quality is good to poor (B through D) depending upon location to population centers. The river receives both treated and untreated sewage as well as significant amounts of industrial waste.

## Quabbin Reservoir

Quabbin Reservoir is the largest body of water in Massachusetts and the largest man-made impoundment in New England. It encompasses approximately 25,000 surface acres when full. Quabbin serves primarily as a domestic water supply source for 42 communities within the Metropolitan District Commission's jurisdiction. Public use of the impoundment is regulated by the MDC through controlled access and specific regulations. Quabbin has developed an excellent and popular sport fishery through the joint efforts of the MDC and the Massachusetts Division of Fisheries and Game. The more important species entering the sport fishery include: landlocked salmon, lake trout, small and large mouth bass, rock bass, pickerel, bluegill, pumpkinseed, brown bullhead, white and yellow perch, brown trout and rainbow trout. Some brook trout are taken in the tributaries.

Unpopulated State owned lands encompass more than 80,000 acres, most of which is covered by a dense coniferous forest. Although the project area contains an abundance of game animals, hunting is not allowed. Recreational use consists of regulated boating, fishing, sightseeing and hiking.

## Millers River Basin

The Millers River rises in Ashburnham, Massachusetts, and flows in a westerly direction for about 45 miles through Winchendon, Athol, and Orange to its confluence with the Connecticut River at Montague and Erving, Massachusetts. It has a drainage area of 392 square miles.

Principal tributaries of the Millers River are the Otter and Tully Rivers. There are two completed flood control dams in the Millers River Basin: Birch Hill Dam on the Millers River, and Tully Dam on the East Branch of the Tully River. The Millers River Basin is characterized by 78% forest cover, 11% open land, 8% wetland, and 3% urban area.

The main stem of the river contains both treated and untreated domestic sewerage and substantial amounts of industrial waste from several communities. The Otter River, one of the main tributaries to the

Millers, is also heavily contaminated with sewerage and industrial waste, but for the most part, the small tributaries within the Millers River Basin are relatively free of pollution.

Good trout habitat exists upstream of the confluence with the Otter River within the Birch Hill and Winchendon areas, and this reach is stocked annually with rainbow trout by Massachusetts Division of Fish and Game. As a result of pollution in the Otter River and downstream reaches of the Millers River, a sport fishery is non-existent. Fish species consist primarily of suckers and bullhead. An occasional large mouth bass is taken well downstream near the confluence with the Connecticut River; however, the existence of this species is entirely dependent on water quality. White-water canoeing is a very popular recreational activity during the spring freshet season.

From the city of Athol extending downstream to the Orange dam, the setting is a wide level valley with the river meandering through an agricultural setting of pastures, meadows, and settled land. The stream bottom is mud and silt with extensive emergent vegetation as is the outlet of Lake Rohunta which joins the Millers River below Athol. The River is backed up by the Orange dam about a mile upstream. The zone between Orange and the Connecticut River is typified by steep banks, a sharp river gradient, long rapids followed by short pools, a complete absence of wetlands, and a boulder strewn rock rubble bottom. Some 22 species of fish are reported for the Millers River watershed. Population magnitude and locations are dependent on the particular species requirements as well as the man-made stress of pollution.

## Tarbell Brook

Tarbell Brook is a small, low gradient stream approximately 7-1/2 miles long from its headwaters to its confluence with the Millers River. Open water areas (which include lakes and ponds) along the stream cover 1-1/2 miles. The total drainage area is approximately 27 square miles of which about five are wetland, less than two are open water, and the remaining area representing upland habitat.

Flow is moderately rapid through forested areas and slow in open wetland areas. Stream width varies up to 30 feet. Depth is variable and measures several feet in some places. Water quality is good (Class B). The adjacent habitat is primarily coniferous forest combined with mixed stands of hardwoods.

The stream is stocked annually with trout by the Massachusetts Division of Fisheries and Game which provide a "put-and-take" sport fishery. Several species of game such as woodcock, grouse, black duck, rabbit, squirrel, and deer inhabit the area.

During high water, Tarbell Brook is canoeable from the New Hampshire border to its confluence with the Millers River.

Priest Brook

Priest Brook, including Scott Brook, (its main northern tributary) extends approximately 14 miles from its headwaters in southern New Hampshire to its confluence with the Millers River. Open water areas cover one mile along the stream which is of moderate to low gradient and flows through forested and wetland areas. Width varies up to 40 feet and depth is variable, generally three feet but as much as six feet in some areas.

The total drainage area is approximately 23 square miles of which about three are wetland, less than one is open water, and the remaining area is upland habitat. Water quality is good (Class B) but below average for trout during summer months due to high temperature and low flow conditions. Adjacent habitat consists of coniferous forest with mixed stands of hardwood.

This stream is stocked annually with trout by the Massachusetts Division of Fisheries and Game which provides a "put-and-take" sport fishery. Waterfowl and other game species are essentially similar in types and number to that found in the Tarbell Brook watershed.

The proposed diversion site would be located approximately four miles due east of the town of Royalston in an unpopulated area, three miles above the confluence with the Millers River. The project area will encompass about 400 acres, including approximately 330 acres of wetland and 70 acres of upland habitat.

The following private developments are located within the project area: An extensive private camping development consisting of approximately 50 trailers and attendent facilities and a gun club facility including a clubhouse, target range, and a one-half acre pond, just north of Winchendon Road.

## Tully Reservoir

The East Branch Tully River extends about 15 miles from its headwaters in southern New Hampshire to its confluence with the West Branch Tully River. Open waters along the stream, including Tully Reservoir, cover six miles. The total drainage area of this river is 56 square miles of which about eight are wetland, six are open water, and the rest upland habitat.

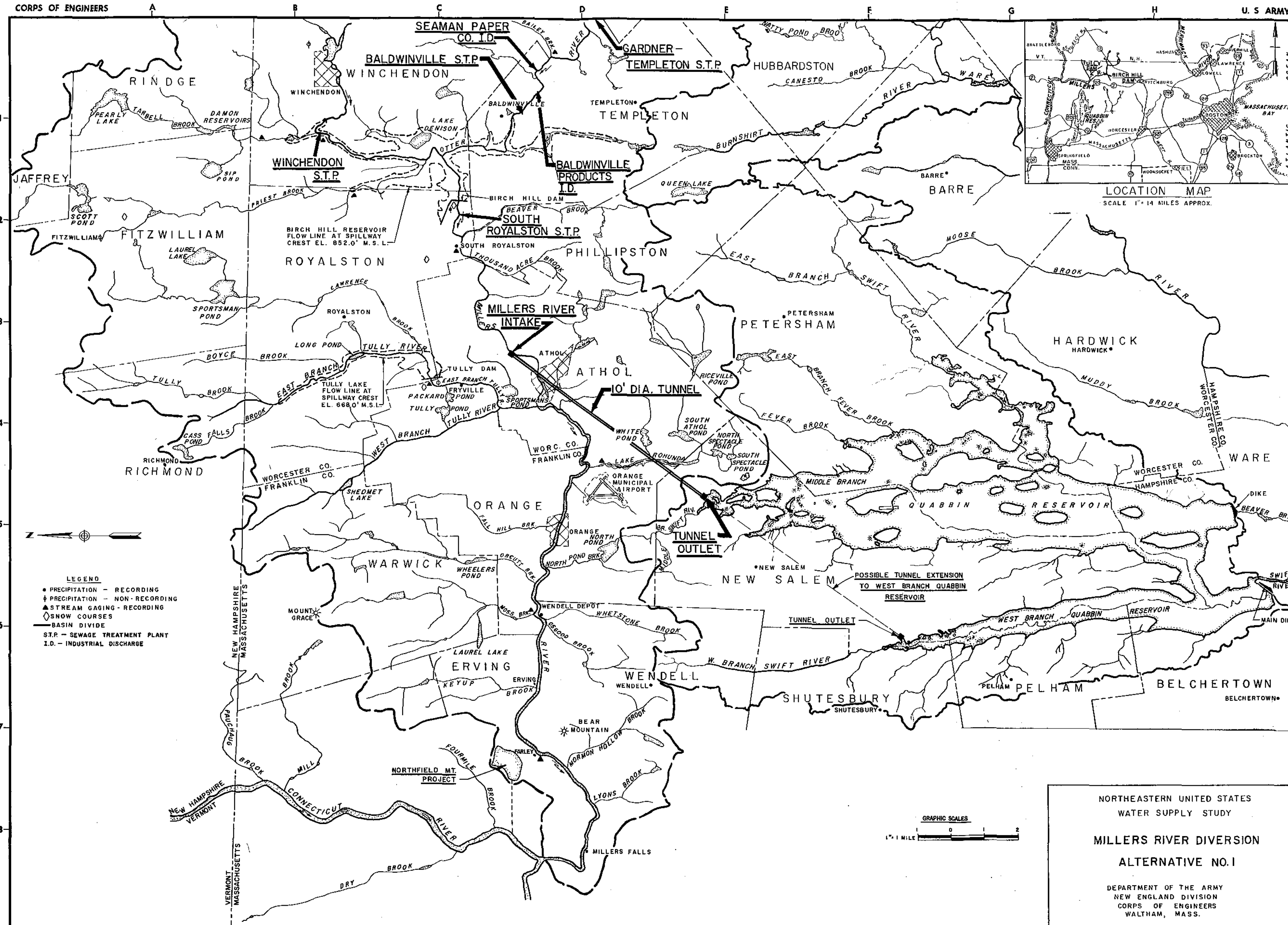
The river is of medium gradient with a section of slow moving water in the Long Pond area. Width varies up to 30 feet and depth up to 8 feet in some areas. Water quality is good (Class B) and is classified as "good trout water" on a seasonal basis. Terrain surrounding the river is moderately steep and heavily forested with mixed deciduous and coniferous trees.

The East Branch of the Tully River is stocked annually with trout by the Massachusetts Division of Fisheries and Game which provides a "put-and-take" sport fishery. Waterfowl and other game species are typical of those found in the Tarbell and Priest Brook watersheds. Considerable hunting activity for birds, small animals, and deer takes place in the basin. Numerous wood roads and trails remaining from past logging operations provide good access for hunters and fishermen. Recreation development potential is excellent and good white-water canoeing occurs below Tully Dam during periods of high water.

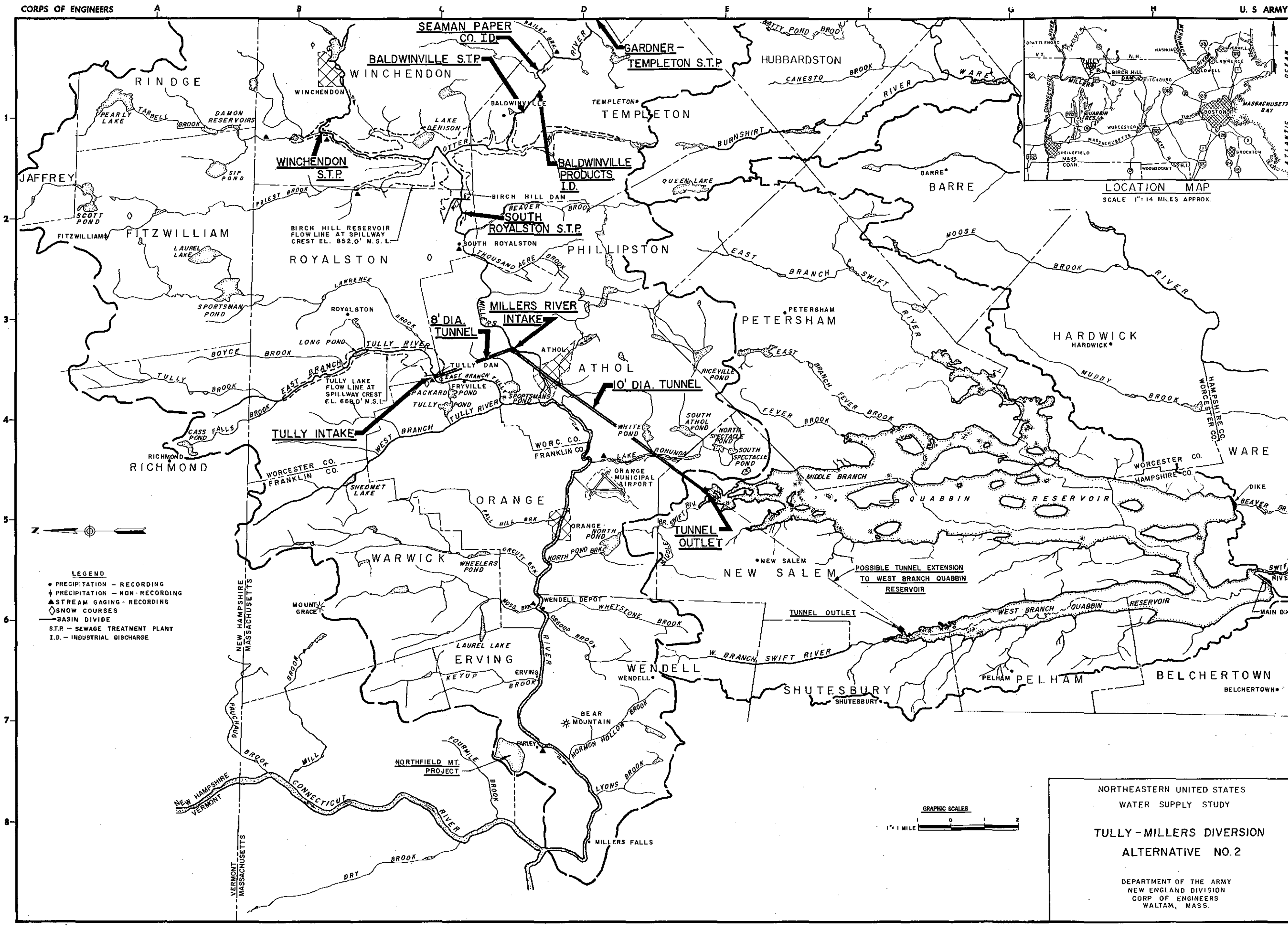
## West Branch Tully River

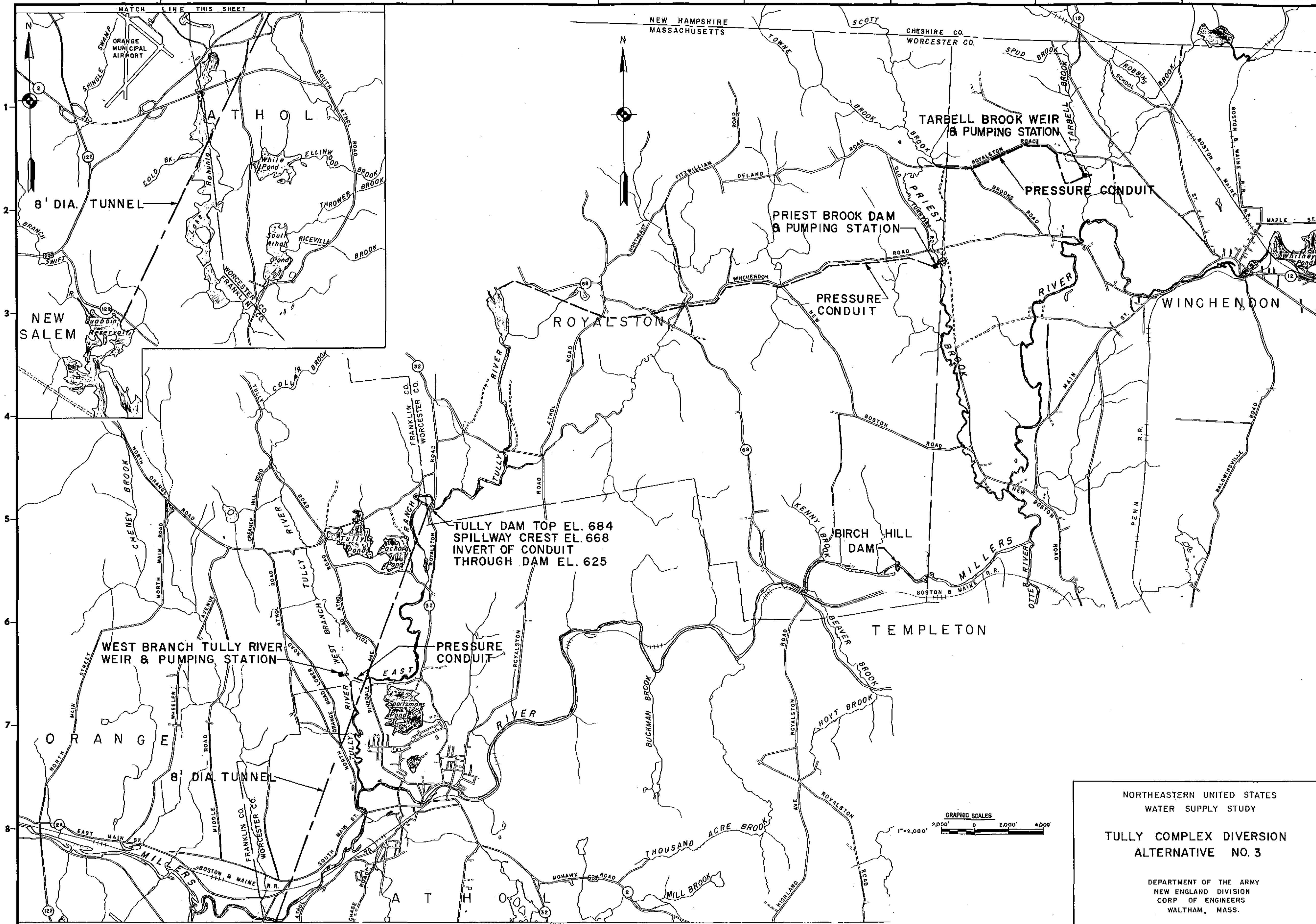
The West Branch of the Tully River, including Tully Brook north of Sheomet Lake, is about 8 miles long, extending from its headwaters in central northern Massachusetts to its confluence with the East Branch of the Tully River, 1-1/2 miles north of Athol. The West Branch is of a moderate gradient, and is up to 35 feet wide with depths up to 5 feet along its course. Open water areas, mainly Sheomet Lake, cover only 1/2 mile along the river. Water quality is good (Class B) and the river is annually stocked with trout by the Massachusetts Division of Fisheries and Game. Total drainage area of the basin is about 19 square miles of which approximately 2 acres are wetland and the remainder upland.

The river flows through a relatively unpopulated and heavily wooded (mostly of mixed coniferous and hardwoods) area. Wildlife found in this basin is similar to that of the nearby East Branch Tully, Priest and Tarbell Brook areas.



CORPS OF ENGINEERS
U. S. ARMY
SEAMAN PAPER CO. I.D.
GARDNER - TEMPLETON S.T.P.
BALDWINVILLE S.T.P.
WINCHENDON S.T.P.
BALDWINVILLE PRODUCTS I.D.
SOUTH ROYALSTON S.T.P.
MILLERS RIVER INTAKE
10' DIA. TUNNEL
TUNNEL OUTLET
POSSIBLE TUNNEL EXTENSION TO WEST BRANCH QUABBIN RESERVOIR
TUNNEL OUTLET
NORTHFIELD MT. PROJECT
BIRCH HILL RESERVOIR FLOW LINE AT SPILLWAY CREST EL. 852.0' M.S.L.
TULLY LAKE FLOW LINE AT SPILLWAY CREST EL. 668.0' M.S.L.
LOCATION MAP
SCALE 1" = 14 MILES APPROX.
LEGEND
PRECIPITATION - RECORDING
PRECIPITATION - NON-RECORDING
STREAM GAGING - RECORDING
SNOW COURSES
BASIN DIVIDE
S.T.P. - SEWAGE TREATMENT PLANT
I.D. - INDUSTRIAL DISCHARGE
GRAPHIC SCALES
1" = 1 MILE
NORTHEASTERN UNITED STATES
WATER SUPPLY STUDY
MILLERS RIVER DIVERSION
ALTERNATIVE NO. 1
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.


CORPS OF ENGINEERS
U. S. ARMY
NORTHEASTERN UNITED STATES
WATER SUPPLY STUDY
TULLY-MILLERS DIVERSION
ALTERNATIVE NO. 2
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORP OF ENGINEERS
WALTAM, MASS.
LOCATION MAP
SCALE 1" = 14 MILES APPROX.
GRAPHIC SCALES
1" = 1 MILE
LEGEND
PRECIPITATION - RECORDING
PRECIPITATION - NON-RECORDING
STREAM GAGING - RECORDING
SNOW COURSES
BASIN DIVIDE
S.T.P. - SEWAGE TREATMENT PLANT
I.D. - INDUSTRIAL DISCHARGE
SEAMAN PAPER CO. I.D.
BALDWINVILLE S.T.P.
GARDNER - TEMPLETON S.T.P.
WINCHENDON S.T.P.
BALDWINVILLE PRODUCTS I.D.
SOUTH ROYALSTON S.T.P.
BIRCH HILL DAM
BIRCH HILL RESERVOIR FLOW LINE AT SPILLWAY CREST EL. 852.0' M. S. L.
MILLERS RIVER INTAKE
8' DIA. TUNNEL
TULLY DAM
TULLY LAKE FLOW LINE AT SPILLWAY CREST EL. 668.0' M.S.L.
TULLY INTAKE
10' DIA. TUNNEL
TUNNEL OUTLET
POSSIBLE TUNNEL EXTENSION TO WEST BRANCH QUABBIN RESERVOIR
NORTHFIELD MT. PROJECT
QUABBIN RESERVOIR
WEST BRANCH QUABBIN RESERVOIR
MAIN DIKE
DIKE
RINDGE
JAFFREY
FITZWILLIAM
WINCHENDON
ROYALSTON
TEMPLETON
HUBBARDSTON
PHILLIPSTON
BARRE
PETERSHAM
HARDWICK
ATHOL
ORANGE
RICHMOND
WARWICK
NEW SALEM
ERVING
WENDELL
SHUTESBURY
PELHAM
BELCHERTOWN
WARE
NEW HAMPSHIRE
MASSACHUSETTS
VERMONT
WORCESTER CO.
FRANKLIN CO.
HAMPSHIRE CO.
MILLERS FALLS
CONNECTICUT RIVER
MILLERS RIVER




NORTHEASTERN UNITED STATES
WATER SUPPLY STUDY

TULLY COMPLEX DIVERSION
ALTERNATIVE NO. 3

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORP OF ENGINEERS
WALTHAM, MASS.

## 3. Environmental Impact of the Proposed Action

### A. Northfield Mountain Water Supply Project

From the outset of this report, efforts have been made to determine the impact of the Northfield Mountain water supply diversion element on the environment. An evaluation was made of the project's impact on the Connecticut River estuary, on the Connecticut River downstream from the point of diversion and on the environment of the receiving water storage reservoir, i.e., Quabbin.

To conduct these investigations, both in-house capability of the New England Division's Environmental Resources Section, as well as contractor personnel, were utilized. The following sections describe in summary the efforts of this integrated multi-discipline team of both Corps of Engineers and Fish and Wildlife personnel and services from three consulting firms.

#### 1) Possible Environmental Impacts of Diversion on the Connecticut River Estuary

In evaluating the possible environmental impacts which might occur with the Connecticut River Estuary, contractor services were utilized extensively. Recognizing that this project's proposed diversion rates are small in comparison to the total river flow and that other proposals for diversion were also being considered in the Millers River Basin, it was decided to test effects[1] which might occur with a large range of postulated diversion rates.

The range of postulated diversion rates tested varied from 600 cfs to 4000 cfs with adherence to a minimum control flow at Montague City of 17,000 cfs and 12,000 cfs, as measured at the U. S. Geological Survey gaging station. Only the 17,000 cfs control flow rate has been approved by the Massachusetts Legislature.

The use of the large range of postulated diversion rates, i.e., 600 to 4000 cfs, with corresponding control flow rates of 17,000 and 12,000 cfs, thus were adopted to allow a full investigation of any potential impacts on the estuary. For example, if the larger postulated diversion rates were tested and limited impact predicted, then the lower diversion rates could be expected to exhibit even less of an impact. This, in fact, is what the results of the study concluded as summarized in the following paragraphs.

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[1] Possible Effects of Various Diversions from the Connecticut River Estuary. Essex Marine Laboratory, Inc., May 1972. Prepared for the New England Division, Corps of Engineers.

a) Changes in river temperature due to diversion should not exceed 0.61° F under the worst case postulated (i.e. 12,000 cfs at Montague City and 4,000 cfs diversion). Although many biological effects of temperature elevations are well known, in most cases, the effects resulting from such a small temperature increment are too small to quantify.

Biological evaluations were made using a 2° F temperature rise in the estuary. The rationale for choosing this temperature rise is twofold. First, biological changes could not be predicted on much less than a 2°F increment of change; and secondly, it would be only an academic exercise to try to refine predictions at a smaller increment of change if, in fact, no significant changes would occur at the 2° F increment. As it turns out, even a 2° F temperature rise would not cause a serious impediment to diversion plans as far as the ecological balance of the estuary is concerned. Keeping in mind that the calculated temperature rise is less than 1/3 the value used in biological evaluation (.61° vs. 2° F), the reader is advised of the apparent conservative nature of the biological evaluation that is summarized in the following paragraphs.

Among the known biological effects of increased temperature, the following may be expected, but it should be kept in mind that even if deleterious, the small change in temperature will result in too small a magnitude of change to be cause for alarm.

All of the conclusions regarding temperature and biological change are based on the worst condition tested, i.e., 4000 cfs diversion with 12,000 cfs at Montague City.

(1) Change in The Time and Location of Shad Spawning - Calculations indicate that a 2° F temperature rise in the river water would have caused spawning to occur 3.4 days earlier in 1967 and 3.6 days earlier in 1968. It is postulated that the most severe postulated diversion conditions would have an insignificant effect on shad spawning.

(2) Shad Egg Size, Abundance, Development Time and Mortality - Shad spawning success in general will not be greatly influenced by any of the postulated diversion. After diversion, temperatures would still remain well within normally occurring variations; and since spawning occurs well above salinity intrusion, any changes in salinity patterns will not affect spawning.

(3) Effects of Survival of Larvae of Shad and Resident Fish Species - Temperature rise and salinity changes that would be brought about by postulated diversion are not expected to affect the egg or larval survival development or growth of any of the fish species tested.

(4) Adult Fish Populations - Some adult fish could feel an effect of the diversion as a result of shifting (in time) of the availability of

a food supply. Food generally becomes available as temperatures exceed 40° F. A 2° F temperature rise would have caused this 40° F temperature to be reached 4.3 and 6.8 days earlier in 1969 and 1970, respectively. Since some adult fish winter in coves and do not move out into the river until temperatures reach 40° F in the coves, they may arrive in the river up to a week after the food supply begins to develop. This assumes that water temperature in the coves would not be influenced by the 2° F temperature rise in the river. More information is needed in this area to draw any definite conclusions, but no problem of significant proportions is anticipated.

(5) Homing Ability and Timing of Arrival of Adult Shad - Adult shad appear to have no homing problems even during extreme low flow springs. Diversion will not reduce flows during these extreme low flow conditions so that it is logical to assume that the shad's homing will not be impaired by diversion. Historically, it has been found that shad tend to enter the estuary when temperatures reach 40° to 43° F. Diversion would cause these temperatures to be reached somewhat earlier, but no problem is anticipated.

(6) Microbiological Population - Because of the paucity of data in some critical areas of basic biology, deemed pertinent considering the postulated diversion, no absolute predictions can be made regarding the ultimate fate of microorganisms in the estuary. Since temperature and salinity rise are so small ( 2° F and a few mg/l) at any given point and since these changes develop over a period of time, no significant qualitative or quantitative alterations of bacterial populations are to be expected in the short run (a few years). Beyond this span any prediction would be speculative.

(7) Invertebrates - 48 recurring species of invertebrates have been identified in 60 months of sampling. Of these, four species are dominant. A 2° F temperature increase can be expected to increase the metabolic activity and probably advance sexual maturity slightly in each of the above species. However, since considered diversions will not be made during summer low flow, high temperature situations, these species are not put under any undue stress. Temperatures after diversion will still be well within the limits of naturally occurring variation, and only minimal adverse effects are to be expected.

b) Freshet conditions should continue throughout the estuary if no diversion takes place when flows are less than 17,000 cfs at Montague City. The duration of freshet will be shortened by 2 to 4 days at both the onset and cessation of freshet in a normal year with diversion. If 12,000 cfs were considered as a control flow, then freshet conditions would be shortened by 3 to 9 days at both the onset and cessation of freshet in a normal year.

c) At a 12,000 cfs controlling flow at Montague City, minor reversals of current may occur in the lower estuary. These should not be sufficient to cause a biologically significant intrusion of salt water from Long Island Sound.

d) Under either controlling flow regime, changes in salinity distribution would be too small to have measurable biological effects.

2) Possible Environmental Impacts of Diversion on the Connecticut River

a) Impact on Aquatic Life

Diversion at Northfield Mountain may affect the aquatic life in the Connecticut River at the diversion point. Fishes, phytoplankton and invertebrate organisms of all life stages, may be entrained and/or entrapped at the pumping facility, whether diversion takes place or not.

The fish population, while composed of many species, contains only a few which are at the top of the food chain. These are: pike perch (walleye pike), small and large mouth bass and yellow perch. Studies by the Massachusetts Division of Fisheries and Game indicate that this reach of the river is underfished and the walleye population is probably almost completely composed of young fish descending the river from above Vernon, Vermont. The probability of great numbers of fish being transported into the pumps appears quite remote. This conclusion is based on several facts. One, only in a very limited part of the intake canal would the current be moving faster than in the main stream, thus older fish would not be carried into the canal against their will. Secondly, bass and catfish have specialized requirements as to where they build their nests, one of which is to locate outside of areas of strong currents. By the time the young leave the vicinity of their nest, they would be old and strong enough to avoid the canal. Further information on the biota and sport fish are provided in General Responses in Section 8. It is quite probable that the eggs and young of minnows and suckers will be carried through the pumping cycle and will have a high percentage of survival. Until such time that a fishway is constructed to pass anadromous fish over the Turners Falls Dam, sea-run fish will not be able to reach the intake canal.

As described earlier, the diversion for water supply purposes would withdraw about 580 cfs from the river, and this flow would then be conveyed to Quabbin Reservoir. Diversions would only be made contingent on a minimum control flow of 17,000 cfs as measured at the U. S. Geological Survey gaging station at Montague.

Based on long-term stream flow records maintained at the Montague City gage, the amount of water to be withdrawn would be about 1% of the average annual run-off from the river. In addition, the maximum decrease in river stage caused by the diversion would be about 0.2 feet at Montague City or about .05 feet at the Thompsonville, Connecticut gage, while average river stage at Montague City at 17,000 cfs is about 12.75 feet.

### b) Change in Concentrations of Nutrients

Based on data developed by the University of Massachusetts as part of a research grant, ammonia-nitrogen loads in the Connecticut River at Northfield for 1963 - 1965 were 3,800 pounds per day. Downstream at Thompsonville, Connecticut, loads for the same period were recorded as 35,900 pounds per day. Phosphate-phosphorous at Northfield for 1963 - 1965 was estimated to be 6,700 pounds per day, while at Thompsonville, about 33,000 pounds per day were recorded.

The diversion from the Northfield Mountain would little affect nutrient levels downstream from the diversion. Maximum differences in concentration at Thompsonville for ammonia-nitrogen and phosphate-phosphorous would be less than .01 ppm.

Since pollution abatement schedules call for installation of waste treatment facilities by 1976, the actual effect of diversion would be even less.

### c) Change in Coliform Levels

Work conducted at the University of Massachusetts on this subject had among its conclusions, "A diversion of Connecticut River water at Northfield would reduce the flow and increase the coliform concentration. This seems reasonable since relatively coliform-free dilution water would be diverted. However, a reduction in flow at Northfield caused by the proposed rate of diversion would probably have no significant effect on coliform concentration at Enfield."

### d) Effect on Downstream Wetlands

As stated earlier, the diversion at Northfield would lower river stages at Montague City 0.2 feet at a maximum. Downstream at Thompsonville, the stage reduction would be .05 feet. Minimal impacts to downstream wetlands are foreseen for these limited river stage reductions.

e) Effect on Planned Water Quality Improvements

Implementation schedules for waste treatment facilities on point sources of pollution have been established by the Environmental Protection Agency and the basin states. All plans for pollution abatement are based on meeting adopted water quality standards during low flow conditions. Since diversions considered in this project would only occur during high flow periods when flow is 17,000 cfs or greater at Montague City, no impact would occur to impair planned water quality goals.

f) Effect on Water Temperature

Studies conducted within the estuarine portion of the basin indicated a maximum of 0.06°F rise could be expected in the estuary following diversion of 600 cfs. Upstream in the mainstem of the Connecticut River, the maximum change in temperature which would be caused by the diversion and subsequent loss of dilution flow would be about 3%. No significant effect on water temperature is anticipated, therefore, from the diversion.

g) Change in Level of Groundwater Table

Discussions were held with the U. S. Geological Survey to determine the impact which the diversion may have on groundwater levels. In the opinion of the Geological Survey, no significant impact to groundwater levels is anticipated as a result of the diversion -- letter, 7 April 1972.

h) Effect of Diversion in Flood Flow Bottom Deposit Scouring

Based on studies [1] by the University of Massachusetts, it was estimated sediment load transport efficiency of the Connecticut River just downstream from the diversion intake would be reduced approximately 3 percent. Downstream from the intake, flow from intervening drainage area would cause the reduction in efficiency to be even less.

i) Effect on Aquatic Life in Vicinity of Diversion Intake

Diversion of water from the Connecticut River to the Northfield Mountain upper reservoir may affect the aquatic life in the vicinity of the river intake. Fishes, phytoplankton and invertebrate organisms of all life stages may be entrained and/or trapped at the pumping facility.

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[1] Appendix C, "Report on formation of public policy on issue of out-of-basin diversion of Connecticut River flood waters to Boston metropolitan area" Water Resources Research Center, University of Massachusetts, Amherst, Massachusetts.

This impact is not occasioned by the fact of the water supply diversion, but rather by the operation of the Northfield Project for power production.

### j) Effect on Downstream Navigation

Below Hartford, Connecticut, the river is used for both commercial shipping and recreational boating. Upstream from Hartford to Holyoke, the river is used for recreational boating, but sand bars and shallow water during low flow greatly impede navigational use.

Normal navigation season flow at Hartford is considered to be 3,750 cfs, while the upper limit is considered to be 66,000 cfs.

The diversion would not affect low flow navigation conditions. High flow conditions would be affected, but not in a negative manner. Instead, the reduction in flow from the diversion would be a minor benefit due to slightly lower velocities.

### k) Effect on Flood Control

The Corps of Engineers is presently working with electric utility officials on an operational schedule of the Northfield Mountain project during flood periods. At present, a draft report presenting methods of operation is under review. It is anticipated that operation of the facility would not have a detrimental effect on flood control measures within the basin.

### 3) Possible Environmental Impacts of Diversion on Quabbin Reservoir

This study [1] generated and evaluated extensive data on the Quabbin and Wachusett Reservoirs and the Connecticut and Millers Rivers systems, with the objective of making predictions on the impacts of diverting portions of these riverine systems into Quabbin Reservoir. Field and laboratory data included approximately 100 parameters, including chemical, physical, biological, and pesticides data. In addition, radiological data, hydrodynamic studies, fisheries information, and pollution abatement plans were considered and evaluated. Finally, other pertinent data available from both public and private sources, especially on the Connecticut River, were evaluated in the light of the objectives of this study. A summary of this evaluation is given in the following sections.

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[1] Water Quality Studies, Connecticut and Millers Rivers Systems and Quabbin and Wachusett Reservoirs, New England Research, Inc., June 1972, Prepared for Metropolitan District Commission and Army Corps of Engineers.

Central to the evaluation was the development of a qualitative model of reservoir dynamics. If water of lower quality is introduced from a river system into a receiver system, there will most likely be a loss in water quality in the receiver system. This loss of water quality is due to various materials in the water. These materials include molecules, ions, suspended inorganic materials, organic debris, and living organisms. One of the central problems of ecology today is to trace the flow of materials from the various compartments of an eco-system.

### a) Possible Impact on Water Quality

In this section, changes in water quality as a result of the proposed diversion are evaluated. The discussion is limited to the more important issues; no attempt is made to discuss all parameters. Subsequent sections will deal with broader ecological issues, and will include most of the biological parameters.

Diversion of Connecticut River water into Quabbin Reservoir in 1976 will initially increase the turbidity of the reservoir water. The final turbidity will depend upon (1) fallout of some material, (2) the relative dilution of Connecticut River water by ambient Quabbin volume, (3) transformations of materials, (4) the influence of ionic strength changes, and the influence of pH changes. Based on only preliminary data, the fallout of material could be significant after a residence time of 60 - 90 days. The dilution, however, can never exceed a factor of about 5 to 10, depending upon what volumes and how much mixing one considers. Also, water originating in the Connecticut River will be between 18 and 19% of the volume of the entire reservoir, depending on the availability of other diversions during the period 1980 to about 2000. Transformations may change the molecules or colloidal aggregates, but will not necessarily cause an elimination. Finally, the Connecticut River water will undergo a drop in specific conductance after it enters Quabbin; this will tend to stabilize the colloidal suspensions. If it is assumed that the Connecticut River will have an average turbidity of less than 25 during freshet flow, and that extremely high values are possible but infrequent occurrences, all factors considered above will tend to bring the final turbidity down to a lower value. While it cannot be predicted what this value will be, it will probably vary between 0.5 (present turbidity) and about 2. Thus, it may not meet future U. S. Public Health Service (1 JTU) standards for drinking water. The turbidity will probably not rise as much during the first two diversion cycles (years 1976 - 1978) because of the smaller relative proportion of total water originating in the Connecticut River.

Ions that form insoluble complexes (Mn, Fe, Ca) tend to precipitate out into the sediment if suitable anions are available. Such anions decrease as the pH becomes more acid, and thus these ions will tend not to precipitate out as the Connecticut River waters mix with Quabbin waters. Depending on the quality of other waters introduced to the reservoir in the future, there may be a tendency to balance. However, it cannot be predicted what the trend will be over a two-decade period, because the exact proportions cannot be predicted and the long-range stability for pH values in all systems is unknown.

There are at least two major concerns on the possible deterioration of water quality that have ecological significance. One concerns oxygen depletion, and the other is the introduction of additional nutrients which can lead to eutrophication.

Available data suggests that Chemical Oxygen Demand (COD) values for the Connecticut River are about twice as high as the Quabbin stations. Both Connecticut River and Quabbin Reservoir waters maintain high $O_2$ levels, and during the freshet flow periods are probably close to saturation. The concern here is an assessment of the potential depletion of $O_2$ from Quabbin waters as a result of the proposed diversion.

COD represents a potential $O_2$ consumption that is measured using a strong chemical oxidizing agent. Depending on the ease with which the material can be oxidized under natural conditions, the full COD may or may not be exerted upon the water.

If most of the COD is in particulate form (which is probably true for the Connecticut River) much of the material with a potential demand for oxygen could settle out either in the Northfield Pumped Storage Reservoir or in upper Quabbin Reservoir after diversion. Although settling reduces the COD of the water column, the potential oxygen demand is conserved in the mud. Moreover, the organic component of the sediment may be acted upon at the mud-water interface, and transformed into more easily oxidized compounds. Some materials in the diverted waters may interfere with biological activity in the mud-water interface and either inhibit or enhance the transformation processes. Seasonal turnover and wind effects can stir up these bottom deposits into the water column. These effects are intensified if the reservoir levels decrease. The resuspension of transformed organic muds can serve to deplete available oxygen quickly because COD that had accumulated over many years through the settling process is suddenly present in the water column. If the stirring of the bottom mud never occurs, then COD that is settled out may be buried in the anerobic sector of the mud and may never exert its $O_2$ demand on the water.

Included in COD values are the oxygen demands of inorganic materials such as iron and manganese. These inorganic species can have high $0_2$ demands if they are in a chemically reduced state. However, in the Connecticut River, laboratory analysis shows that the iron is mainly Fe III and that the manganese may also be already oxidized.

All the above factors make it difficult to predict the impact of diverting Connecticut River waters with a higher COD into Quabbin Reservoir. Localized oxygen-depletion effects have been observed in the eastern arm of the reservoir. It is probable that similar effects will be observed after diversion in the northern part of the reservoir as well. The impact on the hypolimnion in the deeper part of the reservoir cannot be predicted at this time. Oxygen depletion will depend on a complex of biological and chemical processes in these aquatic systems. In conclusion, then, it is very possible that the proposed diversions may result in some localized oxygen depletions in the reservoir. The extent and magnitudes of such depletions cannot be predicted. The impact on Quabbin must be carefully observed and monitored. If necessary, the option of diverting flow to more than one location within the reservoir can be exercised by extension of the tunnel stub to the the West Branch of the Reservoir.

A number of mechanisms can be expected to operate after the diversions of river waters. Much of the larger material will settle out, probably within hours and days. Many transformations can be expected, based on both inorganic and biological reactions. Detergents would be degraded, although no significant MBAS[1] levels were found. As the carbonates from the Connecticut River reach the more acid reservoir waters, equilibria will shift and some $CO_2$ will go off to the atmosphere. Organic materials including the CCE will probably be oxidized. Some $NH_3$ may also be oxidized, but most of it would be transformed by the biota. Color would decrease. This loss of color could be at least tenfold, based on evidence from the existing Ware River diversion. Finally, many highly insoluble organic materials, including hydrocarbon pesticides and organomercury compounds would tend to evaporate, as they reach the relatively large surface area of the reservoir.

The general trend will be towards an improvement in quality as the diverted water is retained in the reservoir. Whether the retention time within the reservoir before the Connecticut River water reaches the general position near the reservoir main water supply outlets is sufficient to cause recovery is unknown. However, the much longer

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[1] MBAS - Methylene blue active substances, found in most household detergents.

retention times to reach the Chicopee Valley water supply outlet could also allow for some recovery. It cannot be predicted that dilution with ambient reservoir volume will not restore the water quality alone. Some "fallout" of materials due to sedimentation, transformation and evaporation must occur to restore quality. The "treatment plant" capacity of the reservoir can probably handle some restoration of water quality. The magnitude of this capacity is now unknown. Because of its capacity to handle waters from the Ware River diversion with efficiency for 30 years of diversion, we may assume it has some reserve capacity. However, assuming that a loss of water quality occurs with some diversions of Connecticut River water, further deterioration will be checked if other sources of supply are added to the reservoir.

In summary, then, during the period prior to the Northfield Mountain diversion, the water quality will deteriorate as the volume in Quabbin Reservoir decreases. This loss of quality could progress to a dangerous point if the volume of hypolimnion waters is drastically reduced. Any losses in quality due to Connecticut River diversion must be judged in the light of water quality loss without diversion. Secondly, the volumes of water represented by Connecticut River origin will be relatively low during the first few diversions. This allows ample time to study the actual impact of diversion during a period of lower potential to cause a negative impact on water quality. Thirdly, future additions of water to Quabbin from other sources should improve the "treatment plant" capacity of the reservoir and thus an improvement in quality may take place. Also, it must be remembered that as the pollution abatement plans are implemented in the 1970's, the quality of riverine waters will improve. Finally, without even further sources of water inflow, Quabbin Reservoir is destined to deteriorate rapidly by the end of the century.

### b) Possible Impact on Ecology

There can be little doubt that increased levels of nutrient chemicals will be detected in Quabbin Reservoir after the implementation of the Connecticut River diversion. However, not all nutrients can be expected to show such an increase in this time period. Phosphorus increases are possible, but not probable. Increases in available carbon, on the other hand, are quite probable if only due to the relatively high alkalinity of the Connecticut River. Also, the fact that fecal contamination of the Connecticut River does occur, increases the likelihood that complex organic molecules will be introduced into Quabbin and possibly into Wachusett where they will become part of the nutrient pool. The future abatement of pollution in the Connecticut River will contribute significantly to the lowering of any such nutrient addition to the reservoir through diversion.

It is important to note that current nitrogen, phosphorus, and carbon levels in Quabbin are sufficient to support larger phytoplanktonic populations than presently exist. Increased levels of these nutrients do not necessarily mean, then, that higher concentrations of algae in Quabbin can be expected as a direct result of the diversion. It is quite possible, however, since nitrogen, phosphorus and carbon appear not now to be limiting, that the Connecticut River diversion may increase the levels in Quabbin Reservoir of some now unknown limiting growth factor, such as a vitamin. Additional studies on limiting growth factors in both Quabbin Reservoir and Connecticut River water is now under way by the MDC.

There is no reason to believe that undesirable algal species will be introduced into Quabbin Reservoir by either diversion. Any changes in the current algal populations in Quabbin will most likely be the result of the response of present populations in Quabbin to changing levels and kinds of nutrients brought about by the diversions.

The proposed diversion of Connecticut River waters into Quabbin Reservoir presents a good possibility of having an impact upon the maintained fisheries of Quabbin. Furthermore, in view of the fisheries management objectives of the Massachusetts Division of Fisheries and Game, the impact would be a negative impact. If it is assumed that undesirable species will be introduced into Quabbin Reservoir, then the consequences could be felt in several ways. First, the present managed ecological balance between species will be lost. Secondly, if the salmonid population is decimated by undesirable species competition, and a warm water fish population predominates, there is good likelihood that the number of angler trips by sports fishermen to Quabbin Reservoir will decline. This, in turn, will reduce the harvest and further influence ecological balance. The issue, then, is not a reduction of the standing crop of total fishes in Quabbin Reservoir, but the disruption of the present success in the management of a salmonid fisheries program. Studies on methods of excluding undesirable species and hence the consequences associated with their introduction are now being discussed by the MDC and the Massachusetts Division of Fish and Game.

Increased concentrations of organic molecules in Quabbin as a result of the Connecticut River system diversion may affect the dissolved oxygen content of Quabbin waters due to the oxygen demand of these molecules as discussed earlier. The magnitude of any overall decrease in oxygen in the hypolimnion of Quabbin Reservoir, however, is not expected to cause significant changes in the present ecology of Quabbin Reservoir. Localized depletions of oxygen in Quabbin Reservoir have been periodically noted over the past half dozen years as a result of the present Ware River diversion. These depletions have been observed only in the southern part of the eastern arm of Quabbin, and have been short lived. The proposed diversions may be expected to produce similar, localized phenomena. The salmonid fisheries in Quabbin are not expected to be affected by any lowering of dissolved oxygen which is localized in the upper portion of the middle arm and in the eastern arm because they are typically found in the main body of Quabbin.

Because of the number of factors governing the disposition of pesticides in surface waters, it is not surprising that only small traces of pesticides were detected in this study. Similar findings are seen in the STORET retrieval data on the Connecticut River. Analyses for aldrin, BHC, DDT, dieldrin, endrin and other pesticides during the 1960's show little or no residues in the water. Finally, the findings of Lichtenberg et al. (1970) in a 5-year summary of pesticides in surface waters of the United States report only trace amounts ( 0.1 ppb) of pesticides in the Connecticut River.

A prediction with some certainty can be made about the ecological effects of pesticides in the proposed diversions. The Massachusetts Division of Fisheries and Game has data that indicate significant levels of DDT, endrin, dieldrin and PCBs in the tissues of lake trout taken from Quabbin Reservoir. These pesticides in lake trout reflect the expected concentrations by the food chain if traces of pesticides are already available in the reservoir ecosystem. Nor were the residues of DDT in fish from the Connecticut River (Lyman et al., 1968) any higher than those reported for the fish in Quabbin Reservoir. While more extensive monitoring of the waters, muds, and biota of both the Connecticut River and Quabbin Reservoir for pesticides would increase the certainty of prediction, it is highly improbable that the proposed diversion will have any important environmental effects.

Similarly, the impacts of the proposed diversions into Quabbin or Wachusett Reservoirs are impossible to discuss in detail until such a time as the specific impacts discussed above can be more fully defined by future studies. On the basis of current data, the possibility of a degeneration in turbidity in Wachusett deserves some mention due to the importance of turbidity in any contemplated future treatment of Wachusett waters prior to their final distribution to consumers. Further studies sponsored by the MDC are presently under way on possible impacts in both Quabbin and Wachusett Reservoirs.

c) Public Health Aspects

Coliform bacteria are indicators of possible human fecal contamination and therefore of the possible presence of human pathogens, including bacteria and viruses. Coliform bacteria are not themselves, however, pathogenic. It is reasonable to assume that concentrations of coliforms will increase in Quabbin Reservoir as a direct result of the Connecticut River diversion. Therefore, the possibility of finding agents of human infection in the area of Shaft 12 in Quabbin will also be increased by the diversion. The measure of real risks to public health associated with this possibility is, however, a function of a number of other variables. These variables include the general health of populations contributing to the fecal pollution of the Connecticut River, treatment of water before its entry into Quabbin, residence time of this water in Quabbin, dilution of diverted waters by Quabbin waters; and finally, treatment prior to final distribution.

While the MDC is currently planning, according to a Massachusetts Department of Public Health directive, to chlorinate diverted waters prior to their entry into Quabbin, varying turbidities of these waters, and the resultant inefficiencies of chlorination, will ensure the possibility that pathogens imbedded within suspended debris could find their way into Quabbin. Chlorination of diverted waters prior to entry into Quabbin depending on turbidity will probably be less important a means of controlling the introduction of these pathogens than will the implementation of present pollution abatement plans for the Connecticut River.

Even with the implementation of present abatement plans, an important question is how long diverted waters can be expected to remain in Quabbin. In general, the natural purification processes of a lake will reduce the coliform concentrations in proportion to the length of time these bacteria are in residence in the lake. The die-off rates of coliform bacteria are generally considered to be similar to die-off rates of pathogens. While recent research indicates that there is not necessarily a direct correlation between the die-off rates of coliform bacteria and pathogens, it is generally assumed that resident times of several weeks provide reasonable disinfection (Fair, Geyer, and Okun, 1968).

Model studies thus far indicate that diverted waters will have reached the general area of Shaft 12 within 2 - 3 months of the time they are introduced into Quabbin. Portions of these waters will be mixed with waters derived from the southerly portions of the main body of the reservoir as they are taken into Shaft 12; other portions will continue in a southward flow to mix eventually with the waters in the western arm. While it can be expected that significant die-offs of pathogens will occur within a 2 - 3 month residence in Quabbin, and that maximum dilutions of diverted waters will probably be realized within one diversion cycle, the possibility that some pathogens may find their way into the Quabbin aqueduct has to be assumed. The possibility that some pathogens will find their way into the Chicopee outlet at Winsor Dam also has to be assumed; however, because preliminary laboratory model studies indicate it will take about 7 months for diverted waters to reach Winsor Dam, and because of the greater dilution of these waters which would then have taken place, the probability of detecting pathogens at the Chicopee aqueduct would be lower than that of detecting them at the Quabbin - Wachusett aqueduct.

Because model studies to date have not taken into account the effect of winds on residence times of diverted waters, and because pertinent information of the die-away phenomenon is by no means complete, it is not now possible to predict the actual number of pathogenic organisms which may possibly find their way into the Quabbin - Wachusett and Chicopee aqueducts as a result of the Connecticut River diversion.

It is important to note that any pathogens which do find their way into the Quabbin - Wachusett aqueduct will be subjected to dilution by Wachusett waters as well as to the self-purification processes of that reservoir. Given the dilutions and residence times of diverted waters in both reservoirs, we conclude that while the introduction of pathogens into Wachusett Reservoir is possible, it is improbable that they will be detected in Wachusett. Finally, any enteric organisms which may be present in Wachusett as a direct result of the contemplated diversion may be easily destroyed by existing or contemplated chlorination within the distribution system.

The presence of mercury at all sampling sites suggests that it is reasonable to assume that mercury is a component of the waters of this region. While the levels are generally low and thus pose no immediate hazards, the possibility of significant concentrations in the food chain must be assumed. Indeed, data from the Massachusetts Division of Fisheries and Game indicate levels of mercury in fish taken from Quabbin Reservoir to be in the range of $10^2$ - $10^3$ ppb, in this regard being similar to levels found in fish in the Connecticut River. Several peak values for mercury in the water column in excess of 5 ppb have been found in some locations, including the Millers River and Quabbin and Wachusett Reservoirs[1]. Most of these values

[1] Note: all of the higher values recorded for reservoir water were recorded in the results of one sampling run. Samples collected in the months prior and following this run indicated lower values.

occurred earlier in the year, and recent data indicate lower values. The reasons for these values are unknown, nor can the present study, due to the sampling situation, define any possible sources. Our conclusions on the impacts of the proposed diversions, however, must be based on comparative data for the proposed donor and receiver systems. On the basis of the data, we must conclude that no public health hazards due to higher levels of mercury can be expected from the proposed diversions. Indeed, the data suggest that lower levels in water exist in the proposed donor systems.

Pesticide information was reviewed. The findings confirm the position that the Connecticut River waters would not present a public health hazard if diverted into Quabbin Reservoir. In the first place the amounts of pesticides are too low, and secondly the evidence indicates trace amounts to be present in Quabbin Reservoir already. Therefore, the proposed diversion would not introduce pesticides into a reservoir that was already free from such compounds before the diversion.

Our data on radioactivity leads us to conclude that no public health hazards will result from the diversions of Connecticut River waters into Quabbin Reservoir. The Lawrence Experiment Station has been testing Connecticut River water as part of the cooperative efforts of the Tri-State Commission for some time, and has detected neither $^{226}Ra$ nor $^{90}Sr$ in the water. Also surface waters, including reservoirs, from all over Massachusetts have been treated in the spring and fall, and no presence of $^{226}Ra$ or $^{90}Sr$ has been detected. On the other hand, some of the STORET Data (Retrieval Date 69/02/27) for 1960's show Connecticut River water with total beta activity in excess of 10 uuc/liter. This is not true for the more recent data. These discrepancies are common for Connecticut River data, and point out the need for continual monitoring. Such continual monitoring is also desirable in view of the future operation of a nuclear power plant at Vernon, Vermont. Studies support the conclusion that, in view of existing guidelines, we see no immediate or long-range public health hazards from radioactivity in the donor systems.

The risks to human health which are inherent in the consumption of any surface waters cannot, of course, be completely eradicated. However, given man's past experience with public water supplies and his present technology, we conclude that those risks which can be associated with the proposed diversion are reasonably comparable with those generally taken in the consumption of Massachusetts surface waters.

A summary of impacts on Quabbin Reservoir, which may be brought about by the proposed diversion via Northfield Mountain, is shown in Table 7.

TABLE 7

## SUMMARY OF PROBABLE IMPACTS OF THE PROPOSED DIVERSION ON QUABBIN RESERVOIR

Note: This summary does not predict the duration of the impact.

| Description of Impact | Relative Probability Impact Will Occur | | | |
|---|---|---|---|---|
| | No significant change over existing conditions | Possible but Probability Low | Probable | Probability High |
| Increase in Nutrient Chemicals | | | C | |
| Increase in Eutrophication | | | C | |
| Modification of Present Equilibration | | | C | |
| Introduction of Undesirable Species | | | | C[1] |
| Increase in Coliform Bacteria | | | C | |
| Increase in Human Pathogens | | C | | |
| Interference with Water Treatment at Quabbin | | | C | |
| Increase in Levels of Toxic Materials | | C | | |
| Increase in Levels of Radioactivity | C | | | |
| Increase in Levels of Pesticides | C | | | |
| Increase in Extent and magnitude of oxygen depletion | | | C | |

C = Connecticut River Diversion

[1] Assuming exclusion devices were not employed.

## B. Millers River Basin Water Supply Project

### 1) Possible Environmental Impacts of Diversion on the Connecticut River Estuary

As described earlier, contractor services were used extensively in evaluating possible environmental impacts which might occur within the Connecticut River estuary following diversions. In this assessment, a wide range of postulated diversion rates were tested. The diversion rates tested varied from 600 to 4,000 cfs, with adherence to a minimum control flow at Montague City of 17,000 and 12,000 cfs. Only the 17,000 cfs control flow rate has been approved by the Massachusetts Legislature.

The use of the large range of postulated diversion rates, i.e., 600 to 4,000 cfs, with corresponding control flow rates were adopted to allow a full investigation of any potential impacts on the estuary. For example, if the larger postulated diversion rates were tested and limited impact predicted, then the lower diversion rates could be expected to exhibit even less of an impact. This, in fact, is what the results of the study concluded.

All of the minimal impacts on the Connecticut River estuary described earlier for the Northfield Mountain Project would apply also to the Millers River Basin. This similarity is occassioned by the fact that the impacts as described are based on a diversion rate of 4,000 cfs with a control flow rate of 12,000 cfs. Since the diversion rate at Northfield Mountain would be 580 cfs and the Millers River Basin project a maximum of 730 cfs, the total diversion rate would be 1,310 cfs. In addition, both projects are being considered using the higher 17,000 cfs control flow rate, thus the impacts as described are conservative. (i.e. greater than would actually be expected with both projects operating).

### 2) Possible Environmental Impacts of Diversion on the Connecticut River

Impacts on the Connecticut River downstream from the Millers River Basin project alone in general would be similar to those described for the Northfield Mountain Project. This conclusion is drawn based on the fact that both projects would divert water in the same magnitude of withdrawal rates. (i.e., Northfield Mountain 580 cfs, Millers River Basin 730 cfs).

With both projects in operation, the descriptions of possible impacts; on coliform levels; planned water quality improvements; ground water table and downstream navigation would be similar. Reduction in stage with both projects in operation would be about .37 feet at Montague City and .12 feet at Thompsonville, Connecticut. No significant impacts to downstream wetlands are foreseen for these limited river stage reductions.

Change in concentrations of nutrients which could be caused by both projects operating would be less than .02 ppm. With the implementation of planned waste water treatment plants, this effect would be even less.

Temperature rises in the mainstem of the Connecticut River, based on the loss of dilution flow by both projects, would be about 7% at a maximum. Sediment load transport in turn would be reduced about 6% at a maximum. Downstream from the intakes, flow from intervening drainage areas would cause temperature rises and sediment transport efficiency losses to be even less.

Some increases in flood control protection to downstream communities could be expected with the diversions operating. However, no major increases in protection would occur.

3) Possible Environmental Impacts of Diversion on the Millers River

The effect of diversion on river flow will be most pronounced at the confluence of the Tully and Millers Rivers in Athol, Massachusetts. Up to 55% of the monthly flow may be diverted during an average year. However, in no case would the flow in the river be reduced below the established rate necessary to protect the river environment.

The possible impact of the diversions on ground water recharge was assessed. To aid in this evaluation, the U. S. Geological Survey (USGS) were asked for their expert opinion. With regard to the possible impacts below the Millers - Tully confluence, the USGS stated "Since operation of Birch Hill and Tully Reservoirs prevents overbank flooding, the proposed diversions will have no effect on ground water recharge from flood plains below the reservoirs."

If the diversions were in operation with existing water quality conditions in the Millers River, some degradation of water quality could occur. However, plans for the implementation of secondary waste treatment facilities call for construction of the treatment plants by

1974. Earliest implementation of any of the alternative water supply projects would be in 1981 - 1983. Thus, these facilities would follow construction of the planned secondary treatment plants. The design criteria for these sewage treatment plants is based on receiving water flow during low flow conditions. Diversions, however, would take place during high flow periods; thus, the diversions would not affect the ability of the river to meet adopted water quality standards.

In the Tully - Millers River Plan, the provision of advanced waste treatment facilities to insure water quality suitable for water supply purposes is included. Therefore, the implementation of either of these alternatives would improve Millers River quality over that presently planned. Impact of this project would be an enhancement of the basin's environment through improved water quality.

Because of the total volume of water which would be diverted, a lessening of the sediment transport and "flushing" action normally experienced in the Millers River could be expected. During the 1971 and 1972 spring runoff period, paper pulp in suspension was noted within the Millers River. Apparently, the turbulence associated with high flow can scour some deposits of pulp and carry them downstream, thereby partially cleansing the bottom habitats. Reduction in peak flows from any of the diversion alternatives, if they were operational, now would tend to reduce the effectiveness of this cleansing action. However, the existing uncontrolled flows are not adequate to clean the river. It is necessary to stop the input of pulp before this suspended load can be reduced. After the planned waste treatment described in the previous paragraph is in operation, the pulp load released to the river will be substantially reduced. Since any diversion considered would occur after the waste treatment plants are in operation, any impact of diversion on "flushing" action should be minimal.

Flow diverted by Tully - Millers River Plan may cause a slight temperature difference in the Millers River. Daily fluctuations of temperature in all river systems are most likely far greater than differences noted between tributaries and the river in the same period.

The maximum calculated decrease in river stage at the Main Street Bridge in Athol, Massachusetts, which could be caused by the diversions, is about 1.5 feet. If the basin had a shallow gradient, which it doesn't, such as many of the coastal streams in eastern Massachusetts, such a decrease might have many environmental considerations. A careful examination, however, of the downstream flood plains which would not be inundated due to this decrease revealed limited areas. Therefore, impacts due to decreased river stages which could be expected on any downstream areas which receive water infrequently are expected to be minimal.

Several cold water species such as trout are now found only in the upstream tributaries while limited species are found in the Millers River itself. Following completion of planned secondary waste treatment and advanced treatment facilities included in the project, fishing opportunities should increase. Diversions would only take place during periods of high flow so that fish passage would not be obstructed by any of the projects during the remainder of the year. In any event, the existing species and any new species would be locked in segments of the river by the existing major dams at Athol, Orange and Millers Falls.

At present, portions of the Millers River mainstem are attractive to the canoe enthusiast.[1] The three reaches of river that would be affected by reduced flows are: 1) South Royalston to Athol, 18 miles described as mostly rapid, very attractive and passable at high water only; 2) Athol to Erving, 11 miles not recommended, mostly smooth and unattractive; 3) Erving to Millers Falls, 6 miles, mostly rapid and very attractive.

Impacts on canoeing in the mainstem Millers River caused by the plan on the three river reaches described above are as follows:

(1) For Reach 1 - South Royalston to Athol, no impacts would occur upstream from the Millers River intake (approximately 16.5 miles). Downstream from the intake, decreased flow may be beneficial during periods of extreme high water; however, diversion may shorten the season on this 1.5 mile reach during lower flow periods in late spring.

(2) For Reach 2 - Athol to Erving, there may be a possible lessening of the available canoeing season. However, this reach is characterized as "unattractive," thus impacts should be limited.

(3) For Reach 3 - Erving to Millers Falls, decreased flow may be beneficial during periods of extreme high water, but diversion may also shorten the season during lower flow periods in late spring. The impact of diversion would be decreased, however, by the contribution of intervening drainage area to river flow.

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[1] A.M.C. New England Canoeing Guide, Published by the Appalachian Mountain Club, 1968 - Vermont Printing Company.

Seasonal inundation of about 15 acres and 1/2 mile of the Millers River mainstem upstream from the diversion intake would be caused by the plan.

4) Possible Environmental Impacts of Diversion on the Tully River

The effect of diversion on river flow will be most pronounced just downstream of the Tully River diversion intake. Up to 74% of the monthly flow could be diverted during an average year. However, in no case would the flow in the river be reduced below the estimated rate considered necessary to protect the river environment.

The possible impact of the diversions on ground water in the Tully River reach downstream to the Millers River was assessed. The U. S. Geological Survey (USGS) were asked for their expert opinion. In response, the USGS stated "Since operation of Birch Hill and Tully Reservoirs prevent overbank flooding, the proposed diversions will have no effect on ground water recharge from flood plains below the reservoirs."

As described in the preceding section on possible impacts in the Millers River, if the diversions were operating now with existing water quality conditions in the Millers River, some degradation might occur. However, as described in the preceding section, the Tully - Millers plan would probably not be constructed until the early 1980's. Existing plans call for secondary waste treatment abatement by the mid 1970's. In addition to these existing treatment plans, advanced waste treatment facilities are included as part of the Tully - Millers River project. Implementation of the existing planned abatement program and the advanced waste treatment plants would provide good quality Millers River water. Impacts on water quality by the project would therefore be minimal.

Because of the total volume of water which would be diverted, temperature changes in the Tully River could be expected. Data collected on the mainstem Millers River and its tributaries, however, revealed daily fluctuations of temperature in excess of differences recorded between the streams themselves. Temperature differentials which could be caused by the diversion of Tully River water, therefore, must be weighed against naturally recurring variations.

The maximum calculated stage reduction in the Tully River, immediately downstream of the project intake, would be about 1.7 feet. The downstream river profile from the intake is fairly rapid to about one mile downstream. For the remaining four miles of Tully River reach to its confluence with the Millers, the Tully River follows a medium gradient profile with a section of slow-moving water in the Long Pond area. During springtime, some wetlands, primarily in the lower three-mile reach, are subject to inundation. During low flow conditions, the waters recede from these areas and they revert to wetlands. It is possible that the diversion project would affect the duration of the flooding cycle of these intermittent wetlands.

Impacts on the Tully River fisheries downstream from the diversion intake are not anticipated. The Tully River is stocked annually with trout by the Massachusetts Division of Fisheries and Game which provides a "put-and-take" sport fishery. In the determination of the control flow rates used by the Tully - Millers project, the need of these fishing activities were considered. There the rates used were designed to preclude any disruption.

At present, the lower four-mile downstream reach of the Tully River is canoeable; however, the river is characterized[1] as slack and sluggish. Reduced flow caused by the project may be expected to possibly reduce canoeing opportunities. However, because of the nature of the river's gradient, such impacts should be limited.

### 5) Possible Environmental Impacts of Diversion on Quabbin Reservoir

This study generated and evaluated extensive data on the Quabbin and Wachusett Reservoirs and the Connecticut and Millers Rivers Systems, with the objective of making predictions on the impacts of diverting portions of these riverine systems into Quabbin Reservoir. Field and laboratory data included approximately 100 parameters, including chemical, physical, biological, and pesticides data. In addition, radiological data, hydrodynamic studies, fisheries information, and pollution abatement plans were considered and evaluated. Finally, other pertinent data available from both public and private sources, especially on the Connecticut River, were evaluated in the light of the objectives of this study. A summary of this evaluation is given in the following paragraphs.

Central to the evaluation was the development of a qualitative model of reservoir dynamics. If water of lower quality is introduced from a river system into a receiver system, there will most likely be a

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[1] A. M. C. New England Canoeing Guide, Published by the Appalachian Mountain Club, 1968 - Vermont Printing Company.

loss in water quality in the receiver system. This loss of water quality is due to various materials in the water. These materials include molecules, ions, suspended inorganic materials, organic debris, and living organisms. One of the central problems of ecology today is to trace the flow of materials from the various compartments of an eco-system.

A major difficulty in evaluating and describing impacts on water quality and ecology which would occur with this plan is the present water quality of the Millers River. As it presently exists, the Millers River water quality is not suitable for diversion as a water supply source. The inclusion of potential diversions from the Millers as an alternative, therefore, is based on anticipated water quality not existing.

This higher quality water is expected following implementation of planned state - federal pollution abatement program and the advanced waste treatment facilities proposed as part of the water supply plans. Since the proposed waste treatment plants would employ a high level of treatment efficiency on pollutants being discharged to the Millers River, a return of the river to its natural background quality could be expected.

As part of the water quality monitoring network established for this report, five stations were sampled on five northern tributaries of the Millers. These tributaries are sparsely settled and not subject to waste discharges. Data collected in the tributaries, therefore, is considered to portray natural background water quality conditions.

The watershed of the various upstream tributaries is a significant proportion of the Millers River drainage area at the diversion intake.

Thus, utilization of upstream tributary data to indicate background water quality in the Millers River after clean-up seems reasonable. Using this approach, a summary of possible impacts of the proposed diversions in Quabbin Reservoir was prepared. These impacts are illustrated in Table 8.

TABLE 8

SUMMARY OF POSSIBLE IMPACTS OF THE PROPOSED DIVERSIONS ON QUABBIN RESERVOIR

NOTE: This summary does not predict the duration of the impact.

| Description of Impact | Relative Probability Impact Will Occur | | | |
|---|---|---|---|---|
| | No significant change over existing conditions | Possible but Probability Low | Probable | Probability High |
| Increase in Nutrient Chemicals | | X | | |
| Increase in Eutrophication | | X | | |
| Modification of Present Equilibration | | | X | |
| Introduction of Undesirable Species | | X | | |
| Increase in Coliform Bacteria | | X | | |
| Increase in Human Pathogens | | X | | |
| Interference with Water Treatment at Quabbin | | X | | |
| Increase in Levels of Toxic Materials | X | | | |
| Increase in Levels of Radioactivity | X | | | |
| Increase in Levels of Pesticides | X | | | |
| Increase in Extent and Magnitude of Oxygen Depletion | | X | | |

6) Possible Environmental Impact Caused by Added Waste Load of Receivers (Northfield Mountain and Millers River Basin Project)

In keeping with the objectives of the environmental impact statement, the impact which added waste loads, occassioned by the additional water supply, from the projects was also investigated. To provide a measure of the added waste load impact, it was assumed that the environmental cost would be considered as the cost of bringing the quality of water back to its original state. Estimates of providing advanced waste treatment to the incremental water supplied were made. It was assumed that 70% of this additional supply would be treated; the remaining 30% would be lost from the system through evaporation, irrigation and consumed process water. The estimated cost of providing the necessary treatment is 3.4 million dollars on an average annual basis.

In the Project Impact Analysis contained in both the Northfield Mountain and Millers River Basin Water Supply Project reports, this added cost of treatment was included in the evaluation of the projects.

7) Possible Environmental Impacts Caused by Construction of the Alternative Projects (Northfield Mountain and Millers River Basin Project)

The planning phase design of the aqueducts and appurtenant structures of the two projects precludes a detailed assessment of possible environmental impacts associated with the construction phase. If authorized, the recommended projects would undergo detailed design which could alter the preliminary design presented in this report. For example, tunnel shaft locations selected may change, which in turn would affect possible environmental impacts of such construction activities as tunnel spoil disposal, selection of haul roads and maintenance areas.

In response to the possible alterations in design and other followup action which might affect the environment, the Corps of Engineers requires four environmental impact statements for each project authorized. These separate statements are prepared for the Planning, Design and Construction phases, and finally for the Operation and Maintenance stages.

The interim report of survey, for which this impact statement was prepared, is a planning stage report. Detailed data, therefore, are not available on all environmental impacts which might be encountered during final design and construction of the project. Sufficient information is available, however, to highlight possible areas of environmental concern which would be considered in the followup phases.

All work on the tunnels in the two projects would be underground. Thus, the majority of this construction activity would not be visible or disrupting to the environment. Since the majority of the tunnel routes is in rock of good tunneling quality, the possibility of disrupting local ground water supplies is low. However, the Northfield Mountain hydroelectric facility recently constructed in the region experienced some limited disruption of individual supplies. Therefore, this possibility should be assessed when the final route is selected.

Total rock spoil from tunnel construction of the two projects is estimated to be about 490,000 cubic yards. In the preliminary design, these quantities would require about 10 acres with a 30 foot depth. Spoil from the tunnel, however, is expected to be of good quality and some or all of the material may be recycled into other local construction projects such as road construction. This potential for recycling would depend on final design and other construction activities under way in the vicinity.

Surface construction activities of the tunnels are expected to be limited to the vicinity of the construction shafts and connecting haul roads to spoil areas if needed. Environmental impacts which should be considered in the followup phases include impact on maintenance areas, haul trucks and other associated construction needs.

In summary, detailed environmental impacts of the construction activities associated with the alternative projects cannot be fully described during the planning phase. Possible impacts, however, would be fully described in followup environmental studies conducted in the design, construction and operation and maintenance stages. Although all possible impacts cannot be quantified at this time, sufficient data exists which indicates no major adverse effects from the recommended projects. This conclusion is based primarily on the fact that the majority of construction activities would be underground. Surface construction activities may have potential impacts, but experience with similar projects indicates that such impacts can be minimized through careful planning in the design and construction phases.

### 8) Possible Environmental Quality Enhancement

#### a) Environmental Health of Quabbin Reservoir

Environmental health of Quabbin Reservoir is presently in danger. Since 1970, water demands upon the Quabbin system have exceeded the safe yield of the Quabbin watershed. This means that on a long term runoff basis, volume and level of Quabbin will decrease until existing inflows are augmented with new sources. To date, the reservoir has not recovered from the drought of the sixties, although 1972 and the winter of 1972 - 1973 were excessively "wet years" and reservoir levels rose significantly.

Water quality conditions, algal growth patterns in the northern portions of Quabbin suggest that progression toward eutrophication is already taking place there. Water quality in the main body of the reservoir is still of a high quality, but if volumes decrease as projected over the years, the relative masses of high versus low quality water will shift toward an overall loss in water quality. Losses in volume will decrease the natural purification or "treatment plant" capacity and possibly the retention times of inflow waters. Losses in the hypolimnion volume could diminish the managed standing crop of salmonid fishes. The depletion of oxygen in the hypolimnion, whether partial or complete, depends a great deal on quantities of reducing agents in the water. Potential impacts on water quality are manyfold. Iron and manganese may be reduced to the ferrous and manganous state and released to the water column. Sulfate may be reduced to hydrogen sulfide gas resulting in obnoxious gas. In general, then, Quabbin may become unacceptable as a water supply source.

When the waters from the recommended projects are introduced into the system, the yields of the system will again exceed the demand, and levels of Quabbin will increase. With careful management and monitoring, eutrophication can be arrested and the reservoir will continue as a highly acceptable water supply source.

#### b) Environmental Health in Receiver Communities

Environmental health in the communities to be serviced by the project would undoubtedly suffer without project implementation. Much has been stated previously of the economic and socio-economic impacts in the receiver area which would accompany construction of the project. Almost without exception these impacts were of a positive nature, maintaining past progress in improving the quality of life. In addition to these economic and socio-economic gains in the receiver area, construction of the project should provide beneficial environmental impacts as well.

Thus, the impact on the environment caused by the recommended project can be viewed from two perspectives. First are those impacts in donor areas on the estuary, Connecticut and Millers Rivers and the receiving water bodies (Quabbin and Wachusett Reservoirs) which would be caused by project implementation. The second perspective is the environmental impacts which would be prevented by project construction. In all cases, possible changes brought about by the recommended project must be viewed in light of the environmental damage which could be expected without the project.

9) Socio-Economic Impacts of the Projects on the Connecticut River Valley

In the evaluation of the socio-economic impacts which the Northfield Mountain and Millers River Basin supply projects may have, two conditions were tested. First, if water was made available to meet 1990 needs; and second, if projects were not constructed. Impacts for both of these situations were then investigated for communities to be serviced by the projects and for those municipalities within the Connecticut River Basin.

Impacts on serviced communities without project implementation are discussed in Section V, under the no-action alternative. Impacts on Connecticut River Basin communities are given in the following paragraphs.

With Project Implementation

1 /Land Use/

In this impact category, both projects would require a total of about 80 acres. Since existing uses are almost entirely limited to undeveloped open space and since acquisition is likely to mean controlled access, the natural character of the taking area will be preserved. In any event, the service population for any of the alternatives is extremely small and significant principally in the eyes of personally affected individuals.

Apart from the recreation issue, the development potential of the host towns with the projects is not thought to be threatened. Given what the towns themselves must recognize as severe geographic disadvantages for industrial growth, it is highly improbable that the sites needed to implement the diversions would ever have apprecia-ble economic value. Their value is chiefly scenic.

## 2 /Population/

Beyond the labor influx associated with construction of the projects, it is highly unlikely that current downward population trends will be reversed. In the decade between 1960 and 1970, no town in the immediate supplier area registered appeciable growth; and Winchendon, Athol and Orange experienced net outmigrations of better than 250 persons each. The principal determinant of any population changes related to the diversions proposed will be the recreation issue. Should the development of recreational facilities take place, it is possible that the supplier area could see a slight increase in residential population, though probably only on a seasonal basis.

Construction-phase labor demands will have at least a temporary effect on suppliers, however. To determine how the combined incomes of that work force would be distributed, the experience during construction of the Northfield Mountain Hydroelectric facility was utilized. Though the project was very much larger -- $90 million, employing a total of some 3,700 persons -- the tasks required (such as tunnelling, concreting, carpentry, iron working, pipe fitting, etc.) are of much the same nature as will be required on the diversion works, and project labor is likely to be drawn from the same sources. In a post-audit of the labor force assembled for construction of the pumped storage project,[1] Clark points out that of the 3,368 people employed in the crafts, fully 84% were hired locally; that is, only 16%, or 477 men moved into the area to obtain project work.[2] The great majority already lived within commuting distance and spent their paychecks locally. Indeed, aside from those immigrants who established temporary addresses for the term of their employ (principally hard rock miners from North Carolina, New York State and other extraregional

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[1] "The Labor Force Associated with the Northfield Pumped-Storage Hydroelectric Project and Its Effects on the Surrounding Communities," Frank Clark, University of Massachusetts, January 1971.

[2] The reverse is true for supervisory personnel. Of 355 persons so employed, roughly 60% were immigrants moving to the area for the duration of the project. Most often families were settled in a population center near the project site or in trailer parks in nearby New Hampshire. In terms of spending, however, the same general patterns apply to "wage" staff as to the field force.

areas who were supporting families left behind) salaries were introduced to the economics of Central Massachusetts and southernmost New Hampshire and Vermont. Thus, apart from the purchase of meals and incidentals, the salaries of both professionals and the field force were spent within the immediate region, but outside the borders of the towns sharing the construction site. As for rents, the largest portion of temporary residents was set up in Greenfield or Montague, Massachusetts rooming houses, housing closer to the construction site being virtually unavailable.

Thus, if the projects were "union jobs" and that is the supposition, the same commutation and spending patterns are likely to apply, though at reduced levels.

## 3 /Municipal Finance/

One other factor seems especially relevant in the determination of economic impacts caused by the projects on supplier areas -- the issue of revenues lost to individual towns because of land absorbed into public holdings and thereby removed from the tax roles. In this particular area of the Commonwealth, tax bases in urbanized as well as rural places are not strongly diversified; and thus, even comparatively minor fluctuations can mean local hardship. Efforts made to detect any significant decreases in collectable revenues were largely unsuccessful. In most cases, local officials were unable to identify exact tract ownerships and relate potential takings to assessments.

Once such a computation can be made, an upper limit to such losses can be established by assuming no compensation. Minimum losses, on the other hand, would occur if either or both the government and the Commonwealth were to make payments in lieu of taxes. Although that is the intention of the latter authority, it is unclear at present exactly what the terms of such an arrangement might be. The Commonwealth has in the past defrayed such losses to communities affected by flood control project takings, and it is not unlikely that special pleading in the legislature will produce the same result again. However restitution is made finally, the objective is to soften the shock of revenue drops and prevent the deterioration of existing municipal services.

## 4 /Commercial Activity/

With a wide distribution of labor, salary spending should be well diffused, with no one city or town experiencing more than marginal increases in commercial activity. The alternative diversion projects may absorb whatever labor surplus is created by the completion of the Northfield Mountain pumped storage facility and maintain the employment status quo. Of course, since scheduling is uncertain, unemployment conditions at the time of construction are unpredictable, and it is possible that the Millers Project will come too late to prevent an employment sag caused by the demobilization at Northfield or offer only substitution effects -- paying salaries obtainable elsewhere in a time of full employment. At present, however, unemployment in Massachusetts is in excess of the national average with a rate of 7.5% compared to the national figure of 5.9%. In the immediate vicinity of the alternative projects in Greenfield, Athol, and Gardner, unemployment is even higher that the State total, with figures of 10.1, 7.7, and 8.5%, respectively. Unless, then, employment opportunities prior to construction alleviate these high unemployment totals, the construction activities of any of the alternative would provide substantial opportunities for employment. In any event, the diversion construction could well absorb the fifty-odd local hard rock miners trained at the hydroelectric facility.

Beyond the salaries generated, short-term economic impacts also encompass the monies paid to local residents through land acquisition. Neither the magnitude nor the distribution of such payments is readily available.

From the designs prepared to date, it is clear that land takings will be held to a minimum. Again, as with salaries, benefits to the regional economy rather than to individuals are to be reckoned not just in terms of dollar totals, but by their fluidity. Clearly, when a land seller receives dollars for his land, it makes a difference to the community whether he saves the money, reinvests it, or spends it.

Long-term economic implications for suppliers center largely around the extent to which the volumes of water diverted affect industries now located in the area. As for the first issue, comments made by industry spokesmen at the public meeting held at Athol in late October 1971 indicate a concern for maintaining flows in the Millers River adequate for process purposes. However, it seems safe to conclude that no industrial enterprise will be jeopardized by high flow skimming operations.

5 /Housing/

During the construction period of any of the projects, there will be an increased demand for rental housing. Probably, established urban centers at Greenfield, Gardner and Athol or Brattleboro and Keene and Hinsdale (trailers) will absorb whatever non-resident labor force appears and that towns nearer construction sites will not be affected. In no event is the stimulation of new housing construction foreseen. Housing prices and property values may rise for the term of construction, but suffer setbacks when the project is completed. Since Greenfield has been identified as an area in which the housing market is sensitive, trends there should be observed as Northfield and Vermont Yankee at Vernon wind down. Adjustments will be required for any data collected to reflect the very much smaller labor force anticipated for this construction job.

## 6/Education/

From the experience of a dozen different towns surveyed by Northeast Utilities for effects on school populations,[1] only in one, Hinsdale, was overcrowding attributed to worker influxes. It should be kept in mind, however, that the nuclear generating station at Vernon, Vermont, and increased business activity in Brattleboro account for much of that effect and obscure the influence of Northfield. Other school systems either had no marked increase in enrollments or cited natural growth rather than project in-migration as the cause of crowding.

As a conservative estimate of impacts felt in the supplier area sample of seven communities, we have used one primary classroom or about twenty youngsters. Noting that Greenfield appears to be a primary response area, we have located the demand there and estimate an average teaching staff expenditure of $8,400.

Busing data were not available. However, because the numbers of new school-age children to be served under the situation caused by construction activities is so small and because their distribution would likely be more general than we have assumed -- that is not just in Greenfield alone -- any change in busing costs would be extremely small.

## 7/Leisure Opportunities/

Effects in this category are directly dependent on the extent to which present policies on public access to water supply reservoirs and tributary streams may be modified. If present stringent practices were to apply to the Millers diversion, resident sportsmen and occasional

[1] Bernardston, Deerfield, Erving, Gill, Greenfield, Hinsdale (N. H.), Leyden, Montague, Northfield, Orange, Warwick, Winchester (N. H.).

vacationers may be deprived of outdoor recreational opportunities now enjoyed in the upper Millers River watershed. Based on statements made by Massachusetts Department of Public Health spokesmen, it appears that total isolation will not be necessary.

All this notwithstanding, the perception of local residents is that they will be "cheated" of their inalienable rights to free access.[1] The Quabbin experience has rankled in their minds for some thirty years, and references to an MDC "no-man's land" are not uncommon. Their fears are of total exclusion.

### 8 / Transportation/

Impacts here are certain to be of a temporary nature. The bulk of construction is to take place below the surface with only small dams, and occassional access shafts at ground level. Mobility patterns in the resident population may change to some degree, but the dominantly rural nature of the area will make such disruptions infrequent.

The construction contemplated will have almost negligible effects by comparison with the recent highway work on Route 2. Heavy trucking will be required for the removal of spoil to fill areas and the delivery of equipment, but intelligent planning can avoid traffic congestion and hazards to residents. Commutation patterns for the work force will have an appreciable effect on the traffic volumes of major arteries. Locations and magnitudes can be reckoned only after the distribution of labor has been established.

### 9 / Community Image and Cohesiveness/

Impacts forecasted for this category for the projects are very small. No physical separation of populations is involved apart from temporary road closings. No aesthetically undesirable structures are planned, save in the sense that any alteration of the natural scene may be thought of by some as undesirable. Yet, it is in this category that the supply areas themselves feel themselves to be the most injured. Their perceptions of loss are very large, and some commentary seems appropriate.

In terms of standard socio-economic categories like population, density, employment, ethnicity, mobility, etc., and particularly in terms

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[1] One must, of course, consider non-governmental limitations as well. Privately owned, posted land is as unavailable to the general public as reservations, indeed less so in many cases.

of attitudes, the immediate diversion environs are so homogeneous as to be spoken of as an entity. Indeed, in the sense that they share a common interest such as in the disposition of Millers River Basin water, they are a single community whose opposition is unanimous.

Because of the nature of the project under consideration, it is revealing to examine the source of the unanimity. Inhabitants feel that the construction of Quabbin Reservoir in the late 1930's was a shock to the cultural and economic life of the area from which it has never fully recovered. As the testimony of several local people at the Orange hearing indicated, many of the residents of the towns affected by the Millers Diversion Plans consider themselves refugees from the Quabbin site.

Residents of the supplier towns feel themselves to be threatened once again. That is the root of their common cause and the most important cohesive factor in their alliance against the diversion proposed. The social psychology operating here is transference; water for Boston means the bureaucratic machinery of the water supply agency which in turn means wanton despoliation of all that local residents hold dear, and that means a repetition of the upheaval brought by Quabbin in the basin.

## Without Project Implementation

In the event that projects are not implemented, the single most important impact in the supplier region will be at Quabbin itself. Biological studies have determined that in the event of a near-complete drawdown, the ecologic viability of the reservoir would be endangered. Moreover, as the water area shrinks, the likelihood of odors and exposure of the unsightly bottom area grows. The recreational opportunities at Quabbin are, therefore, considerably diminished, not to mention the consequences for the receivers of Quabbin water which may change perceptibly in color and taste.

Less dramatic are the direct economic and social impacts on suppliers. First, local stimuli caused by construction activity will be zero. Whatever buffer effect the projects might have had on the labor fallout at Vernon and Northfield and on unemployment in the region will be lost. Whatever dollar gains might have been realized by local economies as a result of labor force spending and landtaking costs will be foregone. It should also be pointed out that the difference between tax revenues collected on property not taken and any payments made in lieu of taxes should implementation proceed could be counted as "savings." As noted above, however, revenue data have not been made available, and it can only be assumed that the amounts involved are quite small on the order of several thousands of dollars in the three towns directly affected.

Finally, if none of the alternative projects were implemented, whatever monetary value might accrue to the surplus waters not diverted would be returned locally. This eventuality is highly unlikely, however, because there is no reason to foresee the development of new water-dependent industry in the immediate donor area, at least in the 1975 - 1990 time frame.

4. Adverse Environmental Effects Which Cannot Be Avoided Should The Plan Be Implemented

The major impact on the hydrology of the donor systems will be to reduce the peak flows of the rivers during high runoff periods in the spring and sometimes in the autumn. A corollary effect of reducing peak flows, is to reduce the amount of flooded area in the river flood plain downstream. According to the U.S. Geological Survey, recharge of ground water aquifers will not be affected during high runoff periods when diversion would take place since flood conditions are already controlled by Birch Hill Dam and Tully Dam.

During each spring diversion period, about 1-2% of the Connecticut River flow volume will end up in Quabbin Reservoir through the Northfield diversion. An additional 1% would come to Quabbin through the Tully diversions if they were completed. For the spring of 1971, the theoretical figures would have been 1.5% had the Northfield diversion been implemented, plus an additional 0.9% by way of the Tully system. These amounts represent 1% of the total annual flow of the Connecticut River at Montague City. No appreciable impact on the hydrology of the Connecticut River and its watershed downstream from the Northfield diversion site is expected. Berger (1971) has estimated that the Northfield diversion to Quabbin would create a stage reduction of 0.2 foot (2 3/8") at Montague City.

There will be a greater effect on the Millers River system since a larger percentage of water would be diverted during diversion periods, but again no appreciable impact on the hydrology of the Millers River watershed is expected. The diversions may also cause a loss in recreational potential for example, canoeing season could be shortened in the late spring during low flow periods. The effect of low flows on the Millers during high diversion periods may produce long term subtle changes in the biota of the stream.

A maximum increase in temperature of .61°F can be expected in the Connecticut River estuary for the worst possible conditions under which a diversion would take place, namely a diversion of 4,000 cfs with the control flow 12,000 cfs at Montague. As shown in section 3-A, a 2°F increase would have negligible effects on marine life. Using a control flow of 17,000 cfs at Montague would result in a smaller value for the maximum temperature increase. In either case, these temperature increases are well within the normal temperature fluctuations in the estuary.

Diversion from the Connecticut River will have some impacts on the waters of Quabbin Reservoir. During the first few diversions the turbidity is expected to increase slightly as the Connecticut River water would only account for about 18-19% of the total volume of the reservoir. However, after more diversions as the Connecticut River water makes up more of this total volume, the turbidity could further increase. To insure the acceptability of water diverted to Quabbin water quality monitoring stations would be installed upstream of the diversion point and in Quabbin itself. The location, parameters to be tested and frequency of testing would be established by the appropriate Federal and State agencies. Acceptance or rejectance of water to be diverted during the life of the project would be determined by these health agencies.

As mentioned in section 3-a, the COD level in the Connecticut River is about twice the COD level in Quabbin, thus, after diversion the COD level in Quabbin could increase. This would depend on a number of factors. For one, if the COD is mainly in particulate form, it could settle out and be buried without using any of the available $O_2$. Some of the COD in the Connecticut River is due to iron and manganese. The iron is already oxidized in the Fe III state and the manganese may also be oxidized. Future pollution abatement plans along the Connecticut River could serve to reduce the COD levels before they reach Quabbin Reservoir.

## 5. Alternatives to the Proposed Action

During the planning stage of this report, a wide range of alternatives to the proposed diversions were investigated. Included in these alternatives were other possible diversions, use of new technology as a means of augmenting existing supplies, non-structural approaches such as reduction of demand and the evaluation of the no-action alternative. A description of these alternatives and their potential, as solutions to the existing problem, is given in the following paragraphs.

### Millers River Basin

Three alternatives were studied within the Millers River Basin to meet the water demands of the expanded regional system. The first is diversion directly from the Millers River above Athol to Quabbin Reservoir. This diversion would result in an average annual yield of 68 mgd and would require advanced treatment of the point sources of pollution on the Millers River, upstream of the diversion site. The second alternative is a combination of one and three. Water would be diverted only from the East Branch Tully River and from the Millers River above Athol, resulting in an average annual yield of 76 mgd. As in the first alternative, advance waste treatment of the pollution sources would be required; but Tully Lake would not be used for water supply storage. Alternative three is the Tully Complex - a series of small diversion works on four tributaries of the Millers River. An average annual yield of 48 mgd is expected with no treatment required before entering Quabbin Reservoir.

As described in Section 1, Alternative No. 2 was selected as the preferred plan for development in the Millers River Basin. Therefore, this section describes the alternative projects considered, i.e., No. 1 - Millers River Diversion, and No. 3 - Tully Complex Diversion.

### A. Alternative No. 1 - Millers River Diversion

From the city of Athol extending downstream to the Orange Dam, the setting is a wide level valley with the river meandering through an agricultural setting of pastures, meadows, and settled land. The stream bottom is mud and silt with extensive emergent vegetation as is the outlet of Lake Rohunta which joins the Millers River below Athol. The River is backed up by the Orange Dam about a mile upstream. The zone between Orange and the Connecticut River is typified by steep banks, a sharp river gradient, long rapids followed by short pools, a complete absence of wetlands, and a boulder strewn rock rubble bottom. Some 22 species of fish are reported for the Millers River watershed. Population magnitude and locations are dependent on the particular species requirements as well as the man-made stress of pollution.

In this alternative, water would be diverted from the mainstem Millers River above Athol, Massachusetts. An inlet structure on the Millers River, a 10-foot diameter tunnel to Quabbin Reservoir and an outlet structure within the reservoir area would be required. At present, proposed pollution abatement plans by Massachusetts State Agencies include secondary treatment on all point sources of pollution on the Millers and Otter Rivers. However, investigations indicate that additional treatment appears necessary to insure a good water supply source and have been included as elements in this alternative.

The diversion site would be located on the Millers River about three miles upstream from the confluence of the Tully and Millers Rivers in Athol, Massachusetts. The structure located in Athol would consist of an inlet to the 10-foot diameter tunnel to Quabbin Reservoir controlled by a combination weir-bascule gate extending across the Millers River. The concrete control structure, 120 feet long, would provide a regulated pool for the inlet shaft. The bascule gate, 70 feet long and 5 feet high, would regulate the water height and velocity to the inlet. The 22-foot diameter morning glory inlet tapering to the 10-foot diameter inlet shaft would be located on the northern bank in the center of a 60-foot square chamber cut in rock. The three 8 x 8 foot gates to the inlet chamber would be opened only when diversions were occurring. By regulating these gates in conjunction with the bascule gates, various combinations of diversion flows and downstream flows can be achieved.

Water diverted from the river would enter the morning glory inlet and drop down the 10-foot diameter vertical shaft into the tunnel. The 10-foot diameter tunnel would run a distance of 7 miles from the Millers River inlet to a point south of Gays Hill on Quabbin Reservoir. The tunnel would be excavated in rock by mole methods and lined with concrete to a finished diameter of ten feet.

An analysis was made of the present and projected loadings of waste discharges upstream from the diversion intake, present and planned treatment, and present and planned waste effluents. Based on available information, further treatment would be required to insure a good quality water for diversion. Our studies indicate that tertiary treatment at the source of pollution is preferred to water treatment at the Millers River intake. The final determination of this additional treatment will be made during the Design Phase. By that time, the planned secondary treatment plants will probably be in operation and the effectiveness of these plants will be known. Also, then, the effect the existing sludge banks will have on the water quality can be measured. It is expected that once the load on the river is minimized, the natural flushing action will wash away large amounts of sludge in the Millers and Otter Rivers resulting in a relative stable water quality.

The operation of this diversion would depend first on the flow in the Connecticut River as measured at the U. S. G. S. gaging station at Montague City, Massachusetts; and secondly, on the flow in the Millers River at the diversion site. On any given day, the flow in the Connecticut at Montague City would be checked to see if the flow is above 17,000 cfs. If it is not, then no diversion would occur. If it was above the 17,000 cfs, then the flow in the Millers River at the diversion site would be checked. If the flow in the Millers River is less than the flow determined to be required for the river and its environment, hereafter referred to as the control flow, then no diversion would occur. This control flow was determined from flow requirements for: assimilation of wastes; for fish and wildlife and is related to the time of year and the drainage area. The following table shows the control flows at the Millers River intake:

TABLE 9

MILLERS RIVER CONTROL FLOW AT INTAKE

| | Jan Feb Mar | Apr May Jun | Jul | Aug | Sep Oct Nov | Dec |
|---|---|---|---|---|---|---|
| CSM | 0.5 | 1.25 | 2.0 | 1.0 | 0.75 | 0.5 |
| CFS | 100 | 250 | 400 | 200 | 150 | 100 |

If the Connecticut River flow is above 17,000 cfs and the Millers River flow is above the control flow for that day, then diversions would occur. In no case would water be diverted lowering the flow in the river below the control flow. But neither would the flow be augmented if it was naturally below the control flow. So, the rate of diversion on any given day could vary from zero to the maximum capacity of the tunnel, 730 cfs.

The total project cost is estimated to be 36 million dollars based on May 1972 price levels. All costs include an allowance for contingencies (20 percent), engineering and design, and supervision and administration. The estimated costs are based on knowledge of the sites and experience on similar projects. Evaluations of property are based on real estate studies and information from local officials, reflecting values in recent sales in the area.

Impacts on the Connecticut River estuary; the Connecticut, Millers and Tully Rivers downstream from the diversion intake; and Quabbin Reservoir would be similar to that described in Section B for the Tully-Millers River Diversion.

### B. Alternative No. 3 - Tully Complex Diversion

The Alternative No. 3 plan for making diversions from the Millers River Basin involves the construction of an 8-foot diameter tunnel from Tully Lake to Quabbin Reservoir, a dam on Priest Brook, and diversion structures on Tarbell Brook and West Branch Tully River. Water would be diverted in a pressure conduit from Tarbell Brook to the proposed Priest Brook ponding area. Pumping facilities at the Priest Brook Dam would convey this water together with Priest Brook water to Tully Lake. A gravity feed tunnel would then divert the two brooks' water plus the East Branch Tully water out of the basin to Quabbin Reservoir. Water from the West Branch Tully could then be pumped into the tunnel near the confluence of the East and West Branches of the Tully River. Recreation and wildlife management programs are also included at these diversion sites.

#### 1) Tarbell Brook Diversion

Tarbell Brook is a small, low gradient stream approximately 7-1/2 miles long from its headwaters to its confluence with the Millers River. Open water areas (which include lakes and ponds) along the stream cover 1-1/2 miles. The total drainage area is approximately 27 square miles of which about 5 are wetland, less than 2 are open water, and the remaining area representing upland habitat.

Flow is moderately rapid through forested areas and slow in open wetland areas. Stream width varies up to 30 feet. Depth is variable and measures several feet in some places. Water quality is good (Class B). The adjacent habitat is primarily coniferous forest combined with mixed stands of hardwoods.

The stream is stocked annually with trout by the Massachusetts Division of Fisheries and Game which provides a "put-and-take" sport fishery. Several species of game such as woodcock, grouse, black duck, rabbit, squirrel, and deer inhabit the area.

The proposed diversion site would be located on Tarbell about 1/2 mile above its confluence with the Millers River and approximately 2-1/2 miles northwest of Winchendon, Massachusetts.

If implemented, the project will seasonally inundate 40 acres of wetland habitat to a depth of 5 feet, including 1/2 mile of free flowing stream.

2) Priest Brook Diversion

Priest Brook, including Scott Brook, (its main northern tributary) extends approximately 14 miles from its headwaters in southern New Hampshire to its confluence with the Millers River. Open water areas cover one mile along the stream which is of moderate to low gradient and flows through forested and wetland areas. Width varies up to 40 feet and depth is variable, generally three feet, but as much as six in some areas.

The total drainage area is approximately 23 square miles of which about three are wetland, less than one is open water, and the remaining area is upland habitat. Water quality is good (Class B) but below average for trout during summer months due to high temperature and low flow conditions. Adjacent habitat consists of coniferous forest with mixed stands of hardwoods.

This stream is stocked annually with trout by the Massachusetts Division of Fisheries and Game which provides a "put-and-take" sport fishery. Waterfowl and other game species are essentially similar in type and number to that found in the Tarbell Brook watershed.

The proposed diversion site would be located approximately four miles due east of the town of Royalston in an unpopulated area, three miles above the confluence with the Millers River. The project area will encompass about 400 acres, including approximately 330 acres of wetland and 70 acres of upland habitat.

The following private developments are located within the project area: an extensive private camping development consisting of approximately 50 trailers and attendent facilities and a gun club facility including a clubhouse, target range, and a one-half acre pond, just north of Winchendon Road, and a major tree farm.

If implemented, the 400-acre site will be cleared and seasonally inundated, including all of Priest Brook above the proposed damsite, and short reaches of Scott and Town Brooks. The entire project area will be subject to periodic inundation and drawdown. During certain times of the year, natural stream flow into the Millers River would be reduced.

3) Tully Reservoir Diversion

The East Branch Tully River extends about 15 miles from its headwaters in southern New Hampshire to its confluence with the West Branch Tully River. Open waters along the stream, including Tully Reservoir, cover 6 miles. The total drainage area of this river is 56 square miles of which about 8 are wetland, 6 are open water, and the rest upland habitat.

The river is of medium gradient with a section of slow moving water in the Long Pond area. Width varies up to 30 feet and depth up to 8 feet in some areas. Water quality is good (Class B) and is classified as "good trout water" on a seasonal basis. Terrain surrounding the river is moderately steep and heavily forested with mixed deciduous and coniferous trees.

The East Branch of the Tully River is stocked annually with trout by the Massachusetts Division of Fisheries and Game which provides a "put-and-take" sport fishery. Waterfowl and other game species are typical of those found in the Tarbell and Priest Brook Watersheds. Considerable hunting activity for birds, small animals, and deer takes place in the basin. Numerous wood roads and trails remaining from past logging operations provide good access for hunters and fishermen. Recreation development potential is excellent; canoeing occurs below Tully Dam during periods of high water.

The proposed diversion site would be located within the existing Tully flood control reservoir. The existing pool forming Tully Lake would be doubled, increasing the present surface area to 620 acres during the summer recreation season. The pool would subsequently be gradually drawn down after Labor Day. Since Tully Lake would become a domestic water supply source, it appears necessary to clear and strip organic material on the bottom in order to protect the water quality.

With the proposed plan of diversion from Tully Reservoir to Quabbin, up to 25 percent of the storage capacity of Tully will be used for the dual purpose of flood control and water supply. During the spring freshet season, this storage will be filled if, and when, inflows exceed downstream requirements and diversion capacity. This stored water will later be diverted to Quabbin, making the full flood control storage capacity of Tully available for the fall hurricane season.

4) West Branch Tully River Diversion

The West Branch Tully River, including Tully Brook, north of Sheomet Lake, is about 8 miles long, extending from its headwaters in central northern Massachusetts to its confluence with the East Branch Tully River, 1-1/2 miles north of Athol. The West Branch is of a moderate gradient, and is up to 35 feet wide with depths up to 5 feet along its course. Open water areas, mainly Sheomet Lake, cover only 1/2 mile along the river. Water quality is good (Class B) and the river is annually stocked with trout by the Massachusetts Division of Fisheries and Game. Total drainage area of the basin is about 19 square miles of which approximately 2 acres are wetland and the remainder upland.

The river flows through a relatively unpopulated and heavily wooded (mixed conifer and deciduous) area. Wildlife found in this basin is similar to that of the nearby East Branch Tully, Priest, and Tarbell Brook areas.

The proposed diversion site would be located two miles north of Athol, in the town of Orange. It would be on the West Branch Tully River about 500 feet above the confluence with the East Branch Tully River, and about 1-1/2 miles above the confluence with the Millers River.

This water supply plan for diversions from the Millers River Basin involves the construction of an 8-foot diameter tunnel from Tully Lake to Quabbin Reservoir, a dam on Priest Brook, and diversion structures on Tarbell Brook and West Branch Tully River. Water would be diverted in a pressure conduit from Tarbell Brook to the proposed Priest Brook ponding area. Pumping facilities at the Priest Brook Dam convey this water together with Priest Brook water to Tully Lake. A gravity feed tunnel would then divert these two brooks' water plus the East Branch Tully water out of the basin to Quabbin Reservoir. Water from the West Branch Tully could then be pumped into the tunnel near the confluence of the East and West Branches of the Tully River. Recreation and wildlife management programs are also included at these diversion sites.

The Tarbell Brook diversion site is located in Winchendon, Massachusetts, about one-half mile upstream of the confluence of Tarbell Brook with the Millers River. The structure consists of a 75-foot long weir and pumping station. A 28-acre pool with a maximum depth of nine feet would be formed by the weir with a top elevation of 840 msl. The inundated area would be cleared and grubbed to improve its appearance. Water would be drawn from the pool and pumped through a 42" diameter pressure conduit running beside Royalston Road to the Priest Brook ponding area. The pumps and pipeline would be designed to carry a maximum of 90 cfs.

The Priest Brook Dam is located on the Winchendon - Royalston town line, just south of Winchendon Road, some 2-3/4 miles upstream from the confluence of Priest Brook with the Millers River. The pool at spillway crest would have a surface area of 400 acres and a maximum depth of 30 feet. The inundated area downstream of Royalston Road has to be stripped or covered with a gravel blanket to prevent degradation of the water. A weir located upstream of Royalston Road would form a 40-acre wildlife pool. Regulation of this pool would occur during the summer and fall to maintain a shallow depth of water (approximately 5 feet). The 45-foot high main dam buffers the river flow and as such the pool is intermittently filled and emptied inundating the permanent wildlife weir.

A pumping station located at the outlet would divert up to 120 cfs through a 72-inch pressure conduit to Tully Lake. The pressure conduit will run west beside Winchendon Road until it intersects a power line running northwest. Then the conduit follows this easement to Long Pond on the East Branch Tully River.

The diversion site on the East Branch Tully River is located at the outlet of the existing Corps of Engineers Tully Flood Control Reservoir. The existing outlet channel would be enlarged and a morning glory intake structure and a 7-foot high modified bascule gate added. Only two inches of the 8.3 inches of run-off storage in Tully would be utilized for reregulating flows for diversion to Quabbin Reservoir. During the summer a recreation pool would be held at elevation 648 msl and no diversions from Tully would occur. In order to improve the water quality, the 620 acres inundated would be cleared, grubbed and stripped. Water diverted would enter the morning glory inlet and drop down the vertical eight-foot diameter shaft into the tunnel. The eight-foot diameter tunnel would run horizontally at elevation 300 msl for some 2.2 miles to the entrance shaft from the West Branch Tully River diversion.

The West Branch Tully River diversion site is located about 800 feet upstream of the confluence of the East and West Branch Tully River. The structure consists of a 320-foot long, 25-foot high earth filled dam with a 50-foot wide spillway, a water intake chamber and a pumping station. A permanent 13-acre pool would be formed by the dam to divert from and for wildlife habitat. A maximum of 90 cfs would be pumped from this pool to the intake shaft through a 30-inch diameter pressure conduit.

The water entering the eight-foot diameter tunnel would join with the flow from Tully Lake running in an 8.6 mile, eight-foot diameter tunnel from the outlet of Tully Lake to a point south of Gay's Hill on Quabbin Reservoir. The tunnel would have a maximum capacity of 390 cfs.

The water quality studies conducted prior to 1971 on the Tully Complex streams were limited basically to summer analysis for pollution abatement. These studies were augmented by our own to determine the water quality of the streams.

The physical and chemical analysis of these waters revealed that no treatment would be required prior to the entrance of this water into Quabbin Reservoir near Gay's Hill. The storage time and dilution provided within Quabbin would result in a good quality water. These streams have a natural color to them from the many swamps within the watershed. Otherwise, the streams would be of excellent quality. This water will not have environmental or public health stress on Quabbin Reservoir; and therefore, does not require either waste or water treatment before entering the reservoir.

As in the other two alternatives, the operation of this diversion would depend first on the flow in the Connecticut River. If the flow in the Connecticut at Montague City is above 17,000 cfs, then the flows at each diversion site would be checked. If the flow at each site is less than the flow determined to be required for the river and its environment, then no diversion would occur. This control flow was determined from flow requirements for assimilation of wastes; for fish and wildlife; and is related to time of year and the drainage area. The following table shows the control flows at the individual diversion sites:

TULLY COMPLEX DIVERSION CONTROL FLOW AT INTAKES

| | Jan Feb Mar | Apr May Jun | Jul | Aug | Sep Oct Nov | Dec |
|---|---|---|---|---|---|---|
| CSM | 0.5 | 1.25 | 2.0 | 1.0 | 0.75 | 0.5 |
| CFS | | | | | | |
| Tarbell | 12.8 | 32.0 | 51.2 | 25.6 | 19.2 | 12.8 |
| Priest | 9.7 | 24.3 | 38.8 | 19.4 | 14.6 | 9.7 |
| E. Br. Tully | 25.2 | 63.0 | 100.8 | 50.4 | 37.8 | 25.2 |
| W. Br. Tully | 9.3 | 23.3 | 37.2 | 18.6 | 25.2 | 9.3 |

If the Connecticut River flow is above 17,000 cfs and the flow in the specific diversion site is above the control flow for that day, then diversion would occur from that one diversion site. In no case would water be diverted lowering the stream flow below the control flow, but neither would the flow be augmented if the natural flow is below the control flow.

The total estimated project first cost is 41 million dollars based on May 1972 price levels. These costs include an allowance for contingencies, engineering and design, and supervision and administration. The estimates are based on knowledge of the sites and experience on similar projects. Evaluations of property are based on real estate studies and information from local officials, reflecting values of recent sales in the area.

Impacts on the Connecticut River Estuary; the Connecticut, Millers and Tully Rivers downstream from the proposed intake; and Quabbin Reservoir would be similar to that described in Section 3 for the Tully-Millers River Diversion.

The impoundments included in this alternative present other problems.

### Tarbell Brook Diversion

If implemented, the project will seasonally inundate 40 acres of wetland habitat to a depth of 5 feet, including 1/2 mile of free flowing stream. The weir would prevent free movement of stocked fish as well as resident species. Diversion of natural high flows may reduce canoeing potential.

### Priest Brook Diversion

If implemented, the 400 acre site will be cleared and seasonally inundated, including all of Priest Brook above the proposed damsite, and short reaches of Scott and Town Brooks. The dam would prevent free passage of stocked fish as well as resident species. The entire project area will be subject to periodic inundation and drawdown. During certain times of the year, natural stream flow into the Millers River would be reduced. A 40 acre waterfowl pool would be made possible by the creation of a low weir above Deland Road.

Potential for recreational opportunities within the project area would be limited to hunting, fishing, hiking, nature study, etc.

### Tully Reservoir Diversion

The proposed diversion site would be located within the existing Tully flood control reservoir. The existing pool forming Tully Lake would double the present surface area to 600 acres during the summer recreation season. The pool would subsequently be gradually drawn down after Labor Day. Since Tully Lake would become a domestic water supply source, the lake bottom would be cleared and stripped of organic material in order to protect the water quality.

With the proposed plan of diversion from Tully Reservoir to Quabbin, up to 25 percent of the storage capacity of Tully will be used for the dual purpose of flood control and water supply. During the spring freshet season, this storage will be filled if, and when, inflows exceed downstream requirements and diversion capacity. This stored water will later be diverted to Quabbin, making the full flood control storage capacity of Tully available for the fall hurricane season.

Flood control storage requirements are the greatest in southern New England during the fall hurricane season and secondly in the spring during the snowmelt season. As a result, in some Corps reservoirs in New England, some seasonal encroachment on flood control storage has been recommended for other worthwhile uses.

If implemented, the proposed project would cause periodic inundation of 300 acres of wetland, which are presently subject to seasonal inundation during natural flood conditions. High flows below Tully Dam during the spring would be reduced. Following the fall drawdown, some lake bottom would be exposed. Recreation development potential for summer day use facilities is high with excellent opportunities for various outdoor activities. Less than 50 acres of upland game habitat would be lost, while fishing and boating values associated with this project would increase.

The environmental impact on the proposed diversion site would be essentially the same as at Tarbell Brook. About 13 acres will be permanently inundated, which includes 1/2 mile of free flowing river. This 1/2 mile stretch of trout stream would be replaced by a marginal waterfowl area. Recreation opportunities would remain limited after implementation of the proposed diversion plan.

Diversion is not expected to significantly affect sport fishing above the confluence with the Otter River. The sport fishery is presently located primarily upstream of the diversion sites and the amount of diversion expected from Tarbell Brook is insignificant compared to the total water volume available in the mainstem of the Millers River.

Effect of diversion on white-water canoeing may be beneficial during periods of extreme high water; however, diversion may shorten the season during low-flow periods in late spring. Diversion would have no effect on canoeing above the confluence with Tarbell Brook.

For alternative No. 3, the pool formed on East Branch Tully River and Priest Brook would be subject to fluctuation. For example, the entire pool in a normal operation may be filled and emptied within a period of less than 3 months. Under such pool fluctuations, the possibility of erosion does exist. These fluctuations, however, are not expected to cause bank sloughing. The erosion instead would be similar to roadbank erosion caused by surface runoff.

Diverting maximum design capacity of 90 cfs from Tarbell Brook and 30 cfs from Priest Brook will affect the stage of the streams below the diversions less than a foot. Nearly all riparian rights along the reaches of Tarbell and Priest Brooks affected by the proposed diversion are controlled by the Corps of Engineers Birch Hill Dam.

Since operation of Birch Hill Reservoir and Tully Reservoir prevent overbank flooding, the proposed diversions will have no effect on groundwater recharge from flood plains below the reservoirs.

Skimming flood flows from Tarbell and Priest Brooks to Tully Reservoir will have no effect on stream flow above the points of diversion, so there will be no change in overbank flooding.

Impoundments present other problems. Shallow ponds, such as those proposed for the tributary streams, tend to reduce the quality of water impounded in them. Water temperatures are increased, algal populations tend to bloom, and dissolved oxygen depletions occur as the algae blooms decline. The short-term outlook for water quality in the impoundments is a decline in quality. The long-term (20-year) projection is definitely toward lower water quality from the impoundment areas.

In general, the longer the retention time, the greater the probability of ecological changes towards the lentic condition. Although specific changes in the ecology of a single impoundment are difficult to predict, it is reasonable to assume that the ecological changes in the impoundments at Tarbell Brook and the West Branch of the Tully River will progress more closely towards a relatively stable lentic condition than will those at Priest Brook, for example. Thus we visualize a whole range of ecological changes in the impoundments..

No Action

In the evaluation of this alternative, it was assumed that any failure to implement additional supplies for the study area would cause socio-economic impacts on serviced communities. To verify this assumption, a quantification of these impacts was necessary.

Estimates of impacts caused by a no-action policy can be expressed in two different ways. First, concrete losses without the diversion total $84 million to 1990 and $738 million to 2020 if average runoff conditions prevailed. Under drought conditions, concrete losses without diversion total $146 million to 1990 and $835 million to 2020.

Categories included in these totals encompass industrial, city emergency, city, revenue: commerce, sprinkling, business investment and domestic investment losses. However, economic losses in these categories say nothing of the ways in which the losses might be allocated. For example, of the approximately $3. 5 million not collected in city revenue in 1990 by all receivers under a no-action policy, there is no way of knowing whether it would be municipal expenditures on recreation or schools that might suffer. This loss in revenue was expressed as 600 classrooms. Similarly, housing units not built are but an alternative manifestation of losses in the private sector.

Social impacts in communities serviced by the supply system under a no-action alternative would be principally "shadow costs" of the concrete losses. To assess the impacts of such shadow costs on the sixty-six receiver communities, the experience of an actual municipality already beset by the kinds of problems anticipated in the event of prolonged water shortage was evaluated.

The town selected for examination was Stoughton, Massachusetts, an industrial - residential community in the Brockton S. M. S. A. An extended interview with Stoughton's Planning Board Chairman produced both background and impact information. Growth in the town has been steadily upward and shows no sign of a downward turn. The principal constraint on continuing growth may be an acute shortage of water.

The town has been searching for water since 1955 and results have been disappointing. The consequences of the resulting water deprivation have been felt across a wide range of community activities.

Although no shifts in the allocations of land use type have occurred, development in the industrial category has been nearly stopped by water shortage. Economic development has been hurt because water using industries have been turned away. This has slightly decreased the stability of the town because the tax base has not expanded quickly enough to keep up with the demands on local revenue. Wages and prices have remained in phase with the rest of the state, but taxes have increased. No Stoughton industries have left because of water shortage, but new industries have gone elsewhere. Presently, only non-manufacturing, non-processing firms are permitted to locate in town, and a $40 million industrial park is now two years behind in its development schedule.

While data projections estimated in this report show population deficits without the provision of additional supply, it does not appear, based on the Stoughton experience, that population growth is sensitive to short term controls and constraints. Stoughton's in-migration continued despite the building ban and shows signs of growing even more quickly now that new housing construction has begun again. Since the lifting of the building ban, over 500 rental units have been built and occupied. The demand for housing has lowered the vacancy rates significantly and stimulated the construction of 3,000 apartment units and the planned development of 3,000 more. Before the ban went into effect, issuances of building permits had declined for two successive years.

Because finding water has been a top town priority, other municipal services have suffered. A sidewalk program has been indefinitely postponed, and only minimal roadway maintenance and construction have occurred. Generally, expenditures have been cut as revenues from expected property tax have dwindled. Estimates range as high as $1,000,000 in tax losses with increases in assessments covering the deficit. The cost of water has doubled in the past two years, and the municipal debt as of 1 January 1970 stood at $320 per capita. Until a mutual help agreement was reached with Easton and Sharon, adequate fire protection was a critical concern. A much needed junior high school has been put off -- an effect attributed to the "extraordinary high expenditures of finding water." As a result, the present junior high is now in double sessions.

As the search for water has become business as usual, citizens appear to have developed some tolerances for the inconvenience of watering bans. However, their latent insecurity about adequate supplies for fire protection and general domestic consumption have made water shortage a perennial political issue on which concern can focus.

Despite the general slowdown in industrial development and its second order consequences on town revenues, the average citizen perceives the water supply problem in terms of his own inability to water outdoors. Lawns and shrubbery are a waste of money, says the homeowner, and the town looks poorer for it. In turn, these feelings are reflected in attitudes about the desirability of the community as a place to live and work.

In addition to socio-economic impacts, a second major impact could occur with the no-action alternative. This second impact regards the probable deterioration in water quality within Quabbin Reservoir which could be caused by lowered reservoir volumes. Quabbin Reservoir presents a complex limnological situation. Some areas of the reservoir, such as the northern sections appear to be progressing toward eutrophication. In the main reservoir body, however, quality is still high. If the pool volume decreases over the years as might occur with the no-action alternative, then there will be a shift towards an overall loss in water quality in the reservoir. Losses in volume will decrease the "treatment plant" capacity and hypolimnion volumes affecting water quality from both an environmental and public health standpoint.

Based on the evaluation of the socio-economic and environmental impacts, the no-action alternative has many disadvantages. Use of this alternative, therefore, does not offer a realistic solution to the short range needs of the study area.

## Weather Modification

The primary source of the water used for public and private water supply in Massachusetts, as in most humid areas, is precipitation falling directly on the areas concerned. It follows then that if precipitation can be increased in a regulated manner, the water supply can also be increased. To this end, several major agencies such as the National Oceanic and Atmospheric Administration (NOAA), the United States Bureau of Reclamation, the American Meteorological Society, and the National Science Foundation are investigating ways of productively modifying natural precipitation patterns. The primary focus of research is in the area of cloud seeding. Other fields of interest are long-term seasonal precipitation forecasting and fog drip augmentation. Since little work has been done on the latter two, and what little has been accomplished is not applicable to the Massachusetts area, only the process of cloud seeding will be reviewed in this section.

### A. Cloud Seeding

Simply stated, rain falls from clouds when water vapor in the clouds condenses around nuclei and forms rain drops large enough to overcome frictional resistance to falling. In technical terms, this process is the conversion of the water vapor from a state of colloidal stability to one of colloidal instability. The concept of artificially induced precipitation by cloud seeding refers to the introduction of particles of foreign substances, such as dry ice and silver iodide into clouds to serve as condensation nuclei. Theoretically, this action will result in condensation of the water vapor and consequent precipitation. In short, it is scientific rain making.

The testing of the engineering and economic feasibility of this theoretical process has been concentrated in experimental projects in the Rocky Mountain and Upper Great Plains regions. Evidence gained through NOAA research suggests that winter cloud systems over Lake Erie may be modified to produce additional precipitation. A cost benefit study was performed for the Connecticut River Basin, but this study was in design only with no actual experimental work involved. Most information regarding the potential of cloud seeding in the eastern United States is derived from commercial cloud seeding operations.

Some of the findings resulting from these studies and experiments are summarized below:

1) The state of the art is such that most researchers look upon the potential of increased precipitation through cloud seeding with

an air of cautious optimism. Study to date, however, has provided little more than a beginning to the solution of many of the problems involved in weather modification.

2) Cloud seeding is impractical during severe drought conditions when water shortages are most critical. The first requisite for cloud seeding is the presence of clouds, and droughts are notable for their lack of clouds. Present technology is not even remotely capable of producing clouds by weather pattern modification. During a temporary interruption of drought conditions, clouds may form over an area. Even under these conditions, however, cloud seeding would not appreciably alleviate water supply problems since most precipitation would be in all likelihood taken up immediately by plants and soil. It is apparent then that water shortages in periods of drought cannot be solved by cloud seeding. Any substantial seeding induced precipitation would have to be produced during non-drought conditions with abundant moisture in the atmosphere.

3) There are many problems that must be solved before substantial technological breakthroughs result. One of the most critical is the inability of researchers to satisfactorily define optimum cloud conditions and seeding techniques and to predict seeding results accurately. In other words, there is an inadequate understanding of the basic cloud processes which determine: a) the "seedability" of a cloud or cloud system, and b) the proper seeding treatment to stimulate rainfall production efficiently in a potentially seedable cloud.

Another problem is the possibility of undesirable effects of seeding. Indiscriminate seeding might increase soil erosion and sedimentation in streams through intensification of the normal rainfall rate of natural storms. There is the possibility also that artificial seeding of clouds might in fact reduce the natural rain producing capacity of the clouds.

4) Estimates of the feasibility of cloud seeding in the eastern part of the country, including New England, are vague and poorly defined. Most recent cloud seeding research has been conducted in the western states. Atmospheric scientists have cautioned that results of seeding experiments in one area of the country must be viewed with caution when applied to other areas characterized by different topography and climate. It is apparent that much research needs to be done in the eastern part of the country. There is data available for parts of this area from commercial cloud seeding operations. However, these operations were not performed under proper scientific and statistical control procedures and any data gathered in such a manner must be used and interpreted with care.

## B. Conclusion

Research has continued to improve the state of the art of weather modification by cloud seeding and other means. At best, however, weather modification is still an inexact science. Studies are unable to predict optimum cloud conditions and seeding results with any degree of accuracy. It is the conclusion of this section, therefore, that at this time weather modification operations to augment water supplies in Massachusetts does not appear to be a viable solution to the immediate water supply problem.

## Desalinization

Desalinization, the process in which brackish and salt water is converted to fresh, is currently being used in some parts of the world as a viable, economically feasible source of fresh water. This process thus was considered for its potential as a future alternative solution to the water supply needs of eastern Massachusetts.

The conversion of saline to fresh water is accomplished through four major processes: distillation-evaporation, membrane separation, crystallization, and chemical differentiation. A descriptive summary of each process is given below.

### A. Distillation-Evaporation

In this process, water containing salt or other impurities is heated and vaporized. The water vapor, free from the salt and other solids which remain behind as the water boils, is then condensed and collected. The system is basically a simple one requiring only a source of heat energy to boil the water, a method of cooling the water vapor (condensation) and various kinds of plumbing and receptacles for the transfer and storage of the water.

Since distillation, by its nature, results in the complete separation of the water vapor from the dissolved salts of the influent, the process produces fresh water of exceptional purity. Because this method removes the water from the salt, rather than vice versa, the quality of the influent is not critical and the system works equally well on water with a high salt content as an only slightly brackish water. For these reasons, among others, distillation is the oldest and best-known process of desalinization.

### B. Membrane Separation

Desalinization by the membrane process is based upon the ability of thin membranes to pass molecules of pure water and retain the ions of salts and other dissolved solids. There are three basic variations to this concept: a) electrodialysis, b) transport depletion, and c) reverse osmosis. The first two variations depend on the electrical properties of the ions involved, while the third depends on a pressure differential existing across the membrane. Of these three variations, the electrodialysis process is the most well established, with many commercial installations throughout the world.

In contrast to distillation, the membrane process separates the salt from the water rather than the water from the salt. Each stage of the electrodialysis process removes slightly less than 50% of the dissolved solids in the water being treated. The more saline water, the more stages are needed and hence more energy is consumed. For this reason, electrodialysis and other variations of the membrane process are more economical when used with brackish water with a salinity of between 5,000 - 10,000 mg/l, as opposed to more saline water. The water can then be refined in stages to the desired degree of purity.

### C. Crystallization

This process relies primarily upon the fact that as water freezes, the ice crystals reject ions of salt. Saline water is frozen and the crystals of pure ice are then skimmed or removed for later use from the still liquid brine. A second method of separation by crystallization employs the hydrate process which is the formation of a crystalline substance by the combination of water with low molecular weight, hydrocarbons or their derivatives. Like ice crystals, these hydrates reject salt ions. It takes less energy to freeze water than it does to boil it, thus this method has an advantage over distillation in that it consumes less energy. The crystallization process has not been widely used, however, and further research into its effectiveness is continuing.

### D. Chemical

In this process either the water or the dissolved salts are made to undergo a chemical reaction which forms a substance which can be easily separated from the untreated water. Ion exchange, a method by which the saline water is passed through treated resin and the salt ions selectively removed, is the most widely used method of chemical desalinization.

The efficiency of ion exchange decreases with time as the "holes" in the resin become filled with salt ions. Once the resin is saturated, the operation must be closed down and the resin regenerated. For these reasons, the process has had only local exposure and small volume use.

### E. Present Application

Sea water can be considered, for all intents and purposes, an unlimited source of fresh water once the technology of desalinization is refined to a point where it is economically feasible. To this purpose, the federal government, through the Office of Saline Water, has promoted extensive study and research into the problems of desalinization. Several model and testing plants and facilities have been constructed to aid in these studies. The research to date concludes that of the four main processes discussed above, distillation and membrane separation are best suited to large capacity plants. Economical considerations dictate that distillation is best for sea water and electrodialysis for brackish water.

Presently more than 300 million gallons per day (mgd) of desalting capacity is installed world-wide. Plants are generally located in arid regions where conventional water sources are high cost or unavailable. Principal areas of use are in the Mid-East and Caribbean tourist islands. In the United States, desalting for municipal water supply has thus far been limited to smaller communities, relatively isolated from sources of conventional supply.

The largest municipal desalting plant in the United States is a 2.6 mgd distillation process in Key West, Florida. Largest in the world is a French-built, 30 mgd distillation plant, recently completed in Kuwait.

A distillation plant was recently proposed for San Louis Obispo and Santa Barbara Counties, California, which would have a capacity of 40 mgd. Construction on this plant which would have been the largest in the world was scheduled to begin in 1973, however, action on this plant has been recently suspended.

## F. Costs of Desalinization

The cost of fresh water produced by desalinization depends upon the capacity of the plant, the type of process used and whether nuclear or fossis fuel is used. In general, the larger the plant capacity, the less the cost per unit of water. As has been mentioned previously, distillation is more economical for the desalting of sea water, while electrodialysis is better for brackish water. The water costs from nuclear fueled plants are approximately 10% less than from fossis fuel when used in large capacity (more than 100 mgd) plants.

The current cost of desalting is about one dollar per thousand gallons. This estimate is based upon an output capacity of 1 mgd, an amount representative of many plants currently in operation. Designs for the larger plants, such as for San Louis Obispo and Santa Barbara Counties, California, indicate costs in the vicinity of 73 cents per thousand gallons at the plant site. To this figure must be added delivery system costs.

## G. Conclusion

Desalinization by numerous processes is already feasible in parts of the world when the natural water supply is either scarce or of poor quality. In these areas, the relatively high costs of water produced by desalinization are justified. Research[1] has indicated that when larger capacity plants are designed and in production, the costs for desalting sea water could ultimately be reduced to approximately 50¢ per thousand gallons, in the size range of the Northfield Mountain Project and Millers River Basin Project, although the proposed California plant would produce water at 73¢ per thousand gallons at the plant site. Even at this reduced cost, however, desalinization is not competitive with present costs of developing natural surface and subsurface water supplies. For example, costs of water from this statement's proposed actions is about 13¢ per thousand gallons.

Aside from the economic costs involved with desalinization, the Office of Saline Water is also investigating the potential hazards to the environment which might occur. In considering placement for any type of desalting plant, environmental factors are as important as any other factor. Pure water is not the only product. A plant will produce extremely concentrated brine as an effluent, plus any waste products from the power source, such as soot, heat, smoke, toxic gasses, etc. So far as brine is concerned, this brine from distillation plants is of high temperature, higher chloride content and may contain concentrations of copper, all of which may prove injurious to the environment. Special design procedures would be required in the cases of estuaries or areas with restricted water interchange, as many life forms present might be adversely affected. Two land methods of disposal have been studied: (1) evaporation to dryness; and (2) deep-well injection. Evaporation is expensive, though this is highly dependent on land costs, presently quite costly in urban areas. Injection method costs are estimated at 25 to 70 cents per 1,000 gallons of brine. Such costs must be added to plant production and distribution costs to arrive at a true cost of water from this technology. At present, the Office of Saline Water is investigating other methods of brine disposal.

The future of desalting in the northeast is described as follows by the Office of Saline Water:[2]

"Existing desalting operations are characterized by several constraining features. Among the most important are high total annual costs, relative to conventional water sources; the need for proof of large-scale plant operation; and the problem of brine disposal. In the future,

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1 Based on data contained in memorandum from Office of Saline Water to New England Regional Coordinator, U. S. Department of the Interior, 17 August 1972, based on 1972 price levels.

2 Ibid.

as technology is further developed, several of the constraints will be lessened, and desalting may prove to be an attractive supplement to water supply in coastal and estuarine areas of the Northeast United States. Desalting processes may also serve future use as an aid in control of water quality." As a result, this report concludes that desalinization not be considered at this time as a viable alternative source of water in eastern Massachusetts for the short-range water supply problems. When and if the technology and efficiency of this process is refined so that it is economically and environmentally competitive with other methods of supplying water, its feasibility can be re-evaluated.

Importation

During the crisis years of the sixties' drought, many newspaper and periodical articles pondered the possibility of diverting water from extra-regional sources as a solution. One of the major basins often mentioned as a water supply source for the Northeast was the Saint Lawrence. As an alternative to developing local resources to meet future water needs, an investigation was made regarding the feasibility of diverting Saint Lawrence flow to meet future needs.

The Saint Lawrence River Basin is an impressive basin, both in its size and the annual runoff from its watershed. The drainage area is about 295,000 square miles at Ogdensburg, New York, which includes over 95,000 square miles of water surface area, most of which is in the five Great Lakes. Storage capacity within the lakes regulates the flow in the river to a large degree. The long term average discharge at Ogdensburg is about 240,000 cubic feet per second (155,000 mgd). From a review of these statistics, it is apparent that the basin, if developed, could meet the forecast supply demands for all of southeast New England.

Engineering studies were conducted to assess various methods and quantities of development from the basin. Cost estimates were prepared for projects which would service all of the Northeast through the year 2020. Construction costs for such facilities were estimated to be as high as 8.5 billion dollars, excluding any necessary water treatment costs. Water delivered from such an undertaking would cost substantially more than similar volumes made available from local resource potential.

In addition to the high cost of water, this alternative also has several other major disadvantages. First, the nature of the project would not allow stage development. Thus, large expenditures of funds would be required for distant long range needs. Second, since the basin is international, negotiations with Canada would have to be held and a treaty consummated prior to diversion. Assuming that Canada would be favorable to such negotiations, at best, any treaty would be in the distant future.

Based on the results of investigations conducted as part of this report, the importing of water to meet short-range water supply needs does not present a viable alternative for the southeastern New England Region.

## Waste Water Reuse As A Municipal Supply

Waste water reuse, especially in industrial process application, has been economically successful in many sections of the country. The Bethlehem Steel Company in Baltimore, Maryland, currently uses about 120 mgd of treated municipal waste from Baltimore and uses this effluent in its quenching and cooling processes. The Dow Chemical Company uses treated sewage from the City of Midland, Michigan for use in its cooling water and fire protection system. In Amarillo, Texas, effluent from the municipal sewage treatment is used as cooling water and boiler make-up water for industries located in that city.

Other uses to which treated waste water has been applied include irrigation of both crop land and lawns, as a fresh water barrier against salt water intrusion, and in some cases as a source of supply for formation of recreation lakes and ponds.

Direct reuse of waste water effluent as a public water supply, however, has not been utilized to a large degree. Advanced waste treatment research and development programs at the Federal level are continuing and pilot plant studies such as the noted Lake Tahoe project are apparently meeting with success in producing a high quality effluent.

The current Drinking Water Standards do not apply to direct reuse of reclaimed water for drinking. In a series of recent articles, the Division of Water Supply Programs, Environmental Protection Agency, (formerly Public Health Service) have described a number of potential health programs which could occur with the use of renovated waste water. As stated in these articles, recent public repercussions from birth defects caused by thalidomine and from the side effects of other new drugs, underscore the responsibility that health officials have in introducing or promoting the use of reclaimed waste water as a domestic source.

Health officials feel that many questions remain unanswered which must be fully investigated if renovated waste water is to be considered for drinking water purposes. Research considered vital was described in an article[1] prepared by the Director and Deputy Director, Division of Water Supply Programs. In their article, it was stated that "before development of intimate personal-contact uses of renovated waste waters, one needs to:

A. Initiate studies on viruses for:

1) Development of improved viral detection and enumeration methodology.

2) Exploration and definition of the basic properties of enteric viruses.

3) Provision of knowledge on transmission of viruses through the aquatic environment.

4) Definition of the impact of viral disease on man through associated epidemiological studies.

5) Development of technology for the positive removal and inactivation of viruses.

B. Investigate the potential problems from bacteria and other microorganisms in reclamation systems.

C. Identify and define the potential health effects of organic and other chemicals not removed by reclamation plants and subject to build-up, and develop techniques to identify and measure readily the concentrations of such chemicals.

D. Dispel the cloud that hangs over the whole subject of reliability for wastewater-treatment-plant operation. Reclamation plants for direct reuse must have fail-safe processes, back-up facilities, alternate means for disposal, continuous monitoring, and bioassay, and they must be operated in an atmosphere that demands reliability. State programs responsible for the operation of wastewater treatment plants

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[1] Lang, W. N. and Bell, F. A., "Health Factors and Reused Waters," Journal American Water Works Association, April 1972.

will require upgrading. Pilot and field-scale testing will be required for the validation of processes and practices prior to their widespread use.

E. Use common sense. Renovated wastewater should not be used for the ultimate personal use -- as a drinking-water supply -- until there is no other practical choice; and then, hopefully, the minimum research will have been completed and the use will be carefully operated and controlled. Meanwhile, in water-short areas, the renovation and reuse of wastewaters for industrial, limited irrigation, and other low human-contact purposes should be investigated and advanced.

The future of direct wastewater reuse, particularly in industrial applications, seems promising. Future water demand forecasts for industrial usage used in this report, in fact, anticipates greater recycling of water in the industrial sector. For example, industrial output projections of Standard Industrial Classification (SIC), category No. 28, Chemicals and Allied Products, indicate a 750% increase by 1990. Thus, if no recycling beyond that presently practiced were implemented, then anticipated water supply needs for this industry would increase over sevenfold. Future industrial supply estimates developed for this report, however, recognize many pressures are being exerted which should alter present industrial water use practices. In the SIC 28 category, described earlier, the possible changes in use practices were estimated to require a 370% increase in supply rather than the 750% which might be expected based on output forecasts.

Use of renovated waste water as a regular domestic supply, however, requires full results of proposed research. Until such research is completed, wastewater reuse as a municipal water supply is not a viable alternative to meet short-range supply needs.

## Ground Water Resources

A study[1] of the ground water resources of Massachusetts was prepared for the Corps of Engineers by the United States Geological Survey. The study was based upon analysis and interpretation of available data and did not include any new exploratory work. The objectives of the study included an estimate of the area extent and sustained yield of principal aquifer reservoirs which might be used for supplementing municipal and industrial water supplies. The cost of producing the water was also estimated.

[1] This investigation was conducted as part of the feasibility study of potential engineering alternatives in the study area.

## A. Occurrence of Ground Water

A water bearing strata of rock material is called an aquifer. The principal aquifers underlying Massachusetts are of three types: 1) Stratified drift, layers of sand and gravel commonly interbedded with some silt and clay; 2) till, a non-stratified, poorly sorted mixture of clay, sand, gravel and boulders; 3) crystalline metamorphic and igneous bedrock. Till and bedrock aquifers yield small amounts of water, suitable only for domestic supplies. Only those aquifers occurring in stratified drift have the potential capacity to sustain large withdrawals of water.

Geologic reports and well logs were studied to determine the distribution and thickness of stratified drift deposits in Massachusetts. Deposits were found about everywhere in the state, but were most extensive in the valleys and outwash plains of the east and southeast area.

## B. Hydrologic Parameters

In order to evaluate the aquifers as potential sources of water supply, their water transmitting and storage characteristics were studied. Permeability values, in gpd/sq. ft. were assigned to various lithologies such as gravel, sand and gravel and coarse - medium - fine sand on the basis of the relationship between grain size and permeability. The transmissibility, in gpd/ft., of a lithologic unit was then determined by multiplying the thickness of the unit by its permeability value. Coefficients of transmissibility and storage were also calculated from controlled pumping and drawdown tests at wells sunk in the aquifers.

The saturated thickness of the aquifers was mapped where data was available. The thickness was determined by subtracting the elevation of the base of the aquifer from the water table elevation. The saturated thickness of stratified drift, although not necessarily indicative of the presence of permeable zones, has been found by investigators to be a useable favorability guide for a general analysis of the ground water withdrawal potential. One further indicator of the water content of a ground water reservoir is the percentage of surface stream flow which is contributed by ground water. This portion of stream flow is termed base flow or ground water runoff. Analysis of past records indicates that average annual base flow of a given stream is approximately equal to Q-60 (stream flow equalled or exceeded 60% of the time) in a year of normal climate and equal to Q-70 in a dry year. The Q-70 flow is considered an index to the amount perennially available for consumptive use without depletion of storage.

The hydrologic criteria described above were applied to the principal aquifer reservoirs of Massachusetts. In this manner the capability of these reservoirs to serve as alternate sources of water supply could be evaluated. The rates of withdrawal from the aquifers were estimated by assuming the following conditions:

1) No recharge occurs for 200 days in dry years and all the water produced during this period is from ground water storage -- it is assumed that reservoirs capable of sustaining withdrawals under these conditions could continue producing forever;

2) The configurations of the reservoirs were idealized to form elongated rectangles;

3) A system of dewatering wells, 24" in diameter and spaced 2,000 feet apart for 2 mgd yields and 1,000 feet apart for 1 mgd yields, was hypothesized to aid in planning and cost estimates;

4) These wells were assumed to have no drawdown attributed to partial penetration, thinning of the reservoir, nor well losses;

5) Available drawdowns in the wells were limited to two thirds of the saturated thickness for water table conditions and to the top of the producing reservoir for artesian conditions;

6) Current withdrawals of ground water were included as a part of the estimated withdrawals.

The results were then tabulated by area and rate of withdrawal in mgd/sq. mile and total withdrawal in mgd.

## C. Conclusions

The survey of ground water resources indicated that the aquifers in Plymouth County and parts of Cape Cod have the capacity to sustain long term, large magnitude withdrawals. The water demand on Cape Cod is increasing at a fast rate; therefore, this area is not considered in this report. The Plymouth County area studied comprises 300 square miles and its estimated safe yield is 300 mgd. This estimated rate exceeds the required quantity established as a goal of this study. Thus, it was concluded that the Plymouth County area could offer a viable alternative source of water supply for eastern Massachusetts.

Cost estimates for the necessary resource development were then prepared. Major development items included in these estimates were land acquisition, cost of ground water well development, water treatment facilities, pumping installations and connecting aqueduct system to the metropolitan service area. The estimated construction cost for the ground water development per million gallons per day (mgd) capacity is about 1.2 million dollars. Costs for the Millers River Basin and Northfield Mountain Projects on the other hand are estimated to be about $540,000 per mgd capacity. Annual costs of ground water development which include interest and amortization; maintenance, repair and operating cost; and major replacement costs are estimated to require charges of about 25¢ per 1,000 gallons produced. Annual costs for the Millers River Basin and Northfield Mountain Projects would require about 13¢ per 1,000 gallons produced.

In addition to the economic costs associated with development of the ground water alternative, there are also potentially significant environmental and socio-economic impacts. For example, land taking activities associated with sanitary protection of the various wells may be substantial. Preliminary estimates of necessary land acquisition for the wellfield development indicate 2,000 to 3,000 acres of land would be necessary. This compares quite unfavorably with the 80 acres estimated to be required for the Millers River Basin and Northfield Mountain Projects.

Connecting pipelines between wells in the wellfield and transmission facilities to point of use would require a large amount of surface construction. Such extensive surface construction would have an impact on the environment in the vicinity of the wellfield and transmission facilities. Since portions of the aqueduct systems would pass through heavily urbanized areas, disruption would be expected to be extensive.

Since all water developed from the wellfield would have to be pumped to the consumer, this alternative would utilize large amounts of electricity. Thus, depending on the method used to provide this power, impacts on the environment may be expected. The Millers River Basin Project would utilize gravity feed and Northfield off-peak power; therefore, no additional potential environmental damage would accrue because of power requirements.

On the basis, then, of cost comparisons and potential socio-economic impacts, use of ground water does not appear to offer an attractive alternative to the proposed project.

### Dual Water Supply Systems

An alternative which has been receiving attention of late has been the use of dual water supply systems. In these systems, a hierarchy of water supply would be established whereby higher quality supplies could be used to furnish a potable source for drinking, cooking, dishwashing, cleaning, bathing and laundering. All other uses could be furnished by a second supply of lesser quality.

Two general methods have been suggested for such a dual system. The first is the possibility of recycling at the point of usage. Under this scheme, drinking, washing and bathing water would undergo treatment and then be further utilized as toilet flush water and outdoor uses. It is estimated that such a system could reduce domestic water use by as much as 50%.

Various systems for in-house reuse or for outdoor usage have been proposed and some are being marketed on a small scale.

Advantages to this system beyond potable water consumption reduction is the reduction in sewage water volume, sewer pipe and pumping requirements. Capital cost outlay for such a system based on limited cost data would be over twice as expensive as water delivered from this report's recommended project. Other disadvantages to this alternative lie with its limited application and accompanying operational experience, potential problems of odor and other aesthetic considerations. Health officials, in general, have not expressed their acceptance or rejection of such systems. However, their general apprehension on introducing less than potable water into the home environment could also reasonably be expected with regard to any system of this nature.

The second method which has been suggested for delivering higher and lower quality water for various uses would require a second distribution system. This second distribution system would carry river water or even sea water to supplement the high quality primary supply source.

Two methods of providing the second (lower quality) distribution system could be employed. The first would involve installation of the entire system immediately. The second, and more practical, method would be on an incremental approach wherein secondary systems are installed in new or replacement buildings above a certain size. The second approach was evaluated in this report. With this approach, water consumption is only reduced at a given time by the building construction that utilizes secondary systems.

To estimate costs for such a system, a report on the New York City area prepared as part of the NEWS Study was utilized. Based on the results of that investigation, preliminary capital cost estimates for such a dual system would be about 6.5 million dollars per mgd saved. The Millers River Basin and Northfield Mountain Projects are estimated to cost about $540,000 per mgd. Therefore, it is quite apparent that use of a dual supply distribution system as an alternative would be an extremely expensive alternative.

In summary, then, use of dual water supply systems does not offer an alternative to the recommended project in this report. Of the two methods, the system which would recycle water at the point of usage holds the more promise for future application.

## Other Diversion Sites

In addition to the Millers River Basin and Northfield Mountain proposals described in this statement, a number of other diversion possibilities were also evaluated. These other possible sources included diversions from: the mainstem Connecticut River at other than the Northfield Mountain location; a major tributary of the Connecticut River, the Deerfield River; the mainstem of the Merrimack River and the Sudbury River, a tributary of the Merrimack, formerly used by the MDC.

### A. Other Connecticut River Basin Alternatives

Alternative methods of diversions from the Connecticut River Basin, such as the Deerfield River or another location on the Connecticut River, could provide an equivalent yield to that described in this statement. Development of either of these proposals, however, would be more expensive than either Millers River proposals or Northfield Mountain. Aside from economic costs, neither alternative appears to present any clear cut advantage from either an environmental or socio-economic standpoint. It appears then that development of these alternative sources would offer an opportunity for providing the necessary short-range water supply need. Their development, however, would be more expensive and would not offer any advantage over the projects described earlier.

## B. Merrimack River Basin Alternatives

### 1) Merrimack River Mainstem

As an alternative to further diversions from the Connecticut River Basin, the potential of developing the Merrimack River mainstem was also investigated. Based on studies to date, use of the Merrimack River, to meet future needs, holds promise. Use of the river to meet immediate needs, however, does not appear to offer an alternative from either an economic or public health standpoint.

At present, the physical, chemical and bacteriological quality of the river is poor. For years the river has been subject to major discharges of municipal and industrial wastes. Because of these discharges, the Merrimack is often characterized as one of the ten most polluted rivers in the United States.

Even with the existing pollution load, the mainstem river is now used as a water supply for the Cities of Lowell and Lawrence. Water treatment facilities for both municipalities are conventional; however, taste and odor problems are experienced periodically at both locations.

Pollution abatement programs to implement secondary waste treatment facilities on point sources of pollution are under way by State and Federal agencies. Costs of these plants are estimated to be 235 million dollars. Upon completion of the abatement programs scheduled for 1976, the river will be improved as a water supply source.

A recent report by the Corps of Engineers,[1] in cooperation with the Environmental Protection Agency, investigated the feasibility of various alternatives for upgrading treatment processes beyond the planned implementation schedule. Cost estimates of the various alternatives ranged from 668 to 1108 million dollars. All of these plans would further enhance the quality of the river for use as a water supply source.

At present, the NEWS study is performing an Interim Report of Survey on those waste water treatment alternatives reported upon in the waste water feasibility report. The objective of this task is the evaluation of the various alternatives for their effectiveness in meeting the goals of the 1972 Water Quality Act. As a companion effort to the waste water element, investigations in survey detail on the river's potential for water supply development are also under way.

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[1] "The Merrimack: Designs for a Clean River," North Atlantic Division, Corps of Engineers, September 1971, Northeastern United States Water Supply Report.

In summary, at present, the Merrimack River Mainstem in Massachusetts is generally of poor quality. Alternative methods of treating the waste water discharges were assessed in a feasibility report by the NEWS Study. Followup survey detail investigations on alternative waste water treatment techniques and methods for developing water supply facilities are presently under way.

Based on studies to date, use of the Merrimack River to meet future water supply needs holds promise. Use of the River to meet immediate needs within the study area does not appear to offer an alternative to this report's recommended project from either an economic or public health standpoint.

2) Sudbury River

In 1846, the Cochituate Reservoir (previously Long Pond and presently Lake Cochituate) was acquired and developed to meet Boston's water needs through diversions from a subdivision of the Sudbury River watershed.

In 1872, the Sudbury River Act was passed which authorized the diversion of a portion of the Sudbury River waters to the Boston Water System. Subsequent to this Act, a series of reservoirs were construced by the Boston Water System and later by the Metropolitan Water District to develop the watershed. Construction on the last reservoir in the basin was completed in 1898 and a total of 75.2 square miles of drainage area was controlled.

In 1947, in response to the availability of supply from Quabbin Reservoir and the higher quality supply from this source, the Massachusetts Legislature transferred control of a number of the reservoirs to the Department of Conservation. The reservoirs transferred represented about 50 square miles of drainage area and were subsequently developed for recreational usage and their water supply use discontinued.

With its available supplies unable to meet its short range needs, the Metropolitan District Commission has reevaluated the potential which the full Sudbury system may have. Based on initial studies, it appears an additional 40 million gallons per day may be made available through flood skimming techniques.

The Sudbury Basin waters, however, have a number of water quality problems. Thus, to provide the potential yield, water treatment facilities would be necessary. Preliminary cost figures for needed facilities are estimated to be about 43 million dollars. In addition, transmission and pumping facilities may be necessary.

In order to fully estimate the potential and costs for redeveloping the Sudbury system, the MDC is preparing to initiate detailed investigations.

In summary, the "redevelopment" of the Sudbury River Basin could add an attractive increment to the available water supplies for this report's study area. Based on preliminary cost estimates, this increment is expected to cost about twice that of this statement's proposed actions. Yet to be determined as part of the MDC further study are the environmental and socio-economic advantages and shortcomings.

C. Conclusion

Alternative development of the Connecticut or Merrimack Rivers was evaluated as methods of meeting short range water supply needs forecast. Although either river basin offers opportunities, their development would be more expensive than the proposed project. In addition to economic considerations, use of the heavily polluted Merrimack River does not appear to offer an attractive alternative from a water quality standpoint for immediate supply needs.

The Sudbury system plan needs further study for a full assessment of its potential. If the Sudbury "redevelopment" plan were to be found attractive and constructed, however, it would be fully compatible with this statement's proposed actions.

## Water Demand Control

The NEWS Study, cognizant of the narrow margin separating available yield and consumer demand, conducted studies on methods available to alleviate this critical water supply situation. Two general approaches to the problem were investigated: the first considered various methods of increasing the supply available to the system. The second approach described in this section was investigation of methods whereby demand could be curtailed.

A. Components of Demand

1) General

Water demand can be classified into four main categories. These are Domestic, Public, Commercial and Industrial. Nationally, of water withdrawn from public systems, 47 percent is delivered to domestic consumers; 13 percent to public uses; 18 percent to commercial; and 23 percent to industrial applications. A description of uses to which water is applied in the various categories is given in the following paragraphs.

2) Domestic

Domestic use, for purposes of this study, includes that water used by the consumer both within his home and that used by him for allied residential uses such as lawn sprinkling and car washing. In house uses of water include drinking, bathing, cooking, washing, and carrying away of wastes.

Total domestic water use in the United States amounts to approximately 73 gpcd. Few studies have been conducted regarding the composition of this demand; however, the U.S.G.S. reports domestic water in Akron, Ohio, was used in the following proportions:

Domestic Water Use

| | |
|---|---|
| Carrying away of wastes | 41% |
| Bathing | 37% |
| Cooking and Washing | 9% |
| Drinking | 5% |
| Clothes Washing | 4% |
| Lawn Sprinkling | 3% |
| Car Washing | 1% |
| Total | 100% |

3) Public

Public or municipal use on a national basis accounts for about 28 gpcd of the average 157 gpcd[1] supplied by public water utilities. Water used in this category is delivered to municipal facilities such as administration buildings, schools, hospitals, golf courses and other facilities used by the community at large. The water delivered in this category, of course, reacts to number and type of services provided. In Boston, for example, with a large number of hospitals and other institutions, it is reported 38 percent of total water use falls within this category. In Wellesley, a suburb of Boston, only 9 percent is recorded as public.

[1] gpcd = gallons per capita per day.

4) Commercial

A significant portion of all water delivered from public supply systems is used by commercial establishments. Nationally, it is estimated about 28 gpcd are used for this purpose. Within this category, is included department stores, restaurants, hotels, laundries and other service elements which serve the general public. No breakdown of water delivered to the commercial sector was available for the Boston Metropolitan area, but it is estimated 850,000 commuters travel daily to the City of Boston. Water supplied to these commuters for their needs while "temporary residents" cannot help but be a significant share of the water supplied to the City.

5) Industrial

Many industrial establishments obtain their water supply from public utilities. Of the average 157 gpcd recorded in the United States, 36 gpcd were used in industrial plants. The water withdrawn by these industries is used for three principal reasons: cooling water; boiler water or water used for the generation of steam and process water, which is water that comes in contact with the product being manufactured.

Available records on industrial use which record individual community usage are limited. On a state-wide basis, about 100 mgd or 13 percent of the publicly supplied water was drawn for industrial use in 1968. Within the MDC service area, a recent telephone survey conducted by the NEWS Study indicated about 8 percent of water withdrawn was used for industrial. On this basis, then, Massachusetts and the MDC service area are not heavily industrial water users if compared to the national percentage of 23 percent.

B. Methods of Controlling Demand

There are basically five methods which have been suggested as effective in controlling demands on water supplies. These are:

a) Changing from flat-rate to metered supply
b) Increasing the price of metered supply
c) Imposing of restrictions on water use
d) Utilization of water saving devices
e) Public water conservation education programs

Each of these methods outlined above are described in the following sections as they might apply to the demand forecasts prepared for this report.

### 1) Metering

The installation of meters which measure the amount of water used by a consumer have been shown to be effective in varying degrees in reducing demand for water supply. With metering, the customer is now charged for the quantity of water used, instead of being charged a flat rate for a period of time regardless of quantity used. Most of the studies conducted regarding the effects of metering indicate domestic in-house use is relatively in-elastic, but lawn sprinkling use and some industrial applications apparently are affected.

Use of metering then appears to present a good opportunity for conservation of a resource. In the Boston area, however, application of this technique to reduce demand is quite limited. Most municipalities in eastern Massachusetts already meter extensively. For example, the MDC system is presently 96 percent metered. Complete metering, therefore, would affect only 4 percent of service connections in this system and not, therefore, affect to any significance water supply demands forecast in this study.

### 2) Pricing Effects on a Metered Supply

#### a) General

A number of articles have appeared in recent years in water supply and water resource professional journals regarding the impact of price increases on water demand. All of these articles attempt to quantify the constraining influence which pricing may have upon demands. In these articles, a number of various pricing techniques have been suggested for administration of price hikes. These include general increases in price levels, seasonal pricing and increasing block rates for varying usage of water. Aside from the administrative technique employed, however, the objective of the articles is to define impact of price increases on demand. Generally, the authors, however, are forced to base conclusions on a generally incomplete and sporadic empirical data base. In the following paragraphs, a brief description of some of the major empirical studies is given. Following the study descriptions, an application of the empirical data findings to the eastern Massachusetts forecast demand is made for both the domestic and industrial water components. Finally, an attempt is made to correlate the results of the empirically derived data to the local water supply system experiences. Although the data presented later is applicable to general pricing increases, the conclusions are felt to apply regardless of administrative technique selected.

In 1957, H. F. Seidel and E. R. Baumann[1] prepared a statistical analysis of various water works data. In their analysis, the authors derived an elasticity coefficient of 1.0 for certain price levels and a lower, inelastic coefficient for lower price levels. The authors, however, noted that they remained skeptical that a rate adjustment has the prompt, proportional effect on water use which the elasticity coefficients suggest. They stated their review revealed that most rate adjustments are moderate enough and water use habits sufficiently stable to consign the rate factor to a "distinctly minor role as an influence on fluctuations in water use."

Linaweaver, Geyer and Wolff,[2] during the years 1961 - 1966, conducted studies to determine patterns of residential water use and factors influencing this use. The results were then used to determine design criteria for water supply systems. These studies were sponsored by the Technical Studies Program of the Federal Housing Administration, and were in cooperation with sixteen water utilities in various climatic regions. Both residential and apartment areas were studied. Climate, economic level of consumers, and pricing systems were considered and concluded as having in that order the major influences on water use.

The economic level of the consumer was considered to influence water use for several reasons. A consumer in a higher valued area is likely to have more water using appliances which increase the overall domestic use. A second reason advanced is that a higher-priced house usually has a larger lawn which will increase the sprinkling demand. Climate is a major factor influencing sprinkling use when there is a lack of precipitation, but it has little effect on in-house use.

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[1] Seidel, Harris F. and Baumann, E. Robert, "A Statistical Analysis of Water Works Data for 1955," Journal of the American Water Works Association, XLIX, No. 12 (December 1957).

[2] Linaweaver, F. P., Jr., Geyer, John C., and Wolff, Jerome B., A Study of Residential Water Use, Washington: Department of Housing and Urban Development Report TS-12, February 1967.

The cost of water also influences the demand. Based on their findings, the authors conclude that cost does not influence in-house water use to a great extent, but would decrease sprinkling use.

Howe and Linaweaver,[1] using the results of the Residential Water Use Study,[2] studied the effect of water pricing in residential areas. Included in the results of this study was the formation of two equations which, according to the study, described the relation of price on use.

The domestic in-house demand was considered best expressed by the following linear equation:

$$g = 206 + 3.47v - 1.30p$$

where $g$ = gallons per day per dwelling unit
$v$ = market value of dwelling unit in thousands of dollars
$p$ = price per 1000 gallons in cents

By use of this equation, the authors concluded that the effect of price on demand and the price elasticity of domestic use could be determined.

Based on their use of this equation, Howe and Linaweaver next concluded that domestic in-house use represented a demand relatively inelastic with respect to pricing changes.

Effect on summer sprinkling demands by pricing was considered as described by the following equation:

$$g = 3657\, r^{0.309}\, p^{-0.93}$$

where $r = b(w - 0.6s)$

and $p$ = price per 1000 gallons in cents
$b$ = irrigable area in acres surrounding dwelling unit
$w$ = average summer potential evapotranspiration in inches calculated by the Thornthwaite method about 10" in the eastern United States
$s$ = summer precipitation in inches

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[1] Howe, Charles W. and Linaweaver, F. P. Jr., "The Impact of Price on Residential Water Demand and Its Relation to System Design and Price Structure," Water Resources Research, III, No. 1 (1967).

[2] Linaweaver, F. P. Jr., Geyer, John C., and Wolff, Jerome B. A Study of Residential Water Use, Washington: Department of Housing and Urban Development, Report TS-12, February 1967.

From use of this equation, it was determined that the sprinkling demand was responsive to price change. The Howe and Linaweaver work indicated, then, that residential water demand is dependent on the price charged. Typical in-house demands exhibited a price elasticity of -0.23,[1] e.g., a 10% increase in price will reduce demand by 2.3%, while the price elasticity for sprinkling demands was 0.93. Sprinkling use is, therefore, more strongly affected by price change than domestic use. The authors felt that pricing could be used as an effective tool to decrease average day demands and increase revenue.

Because of the different industrial water use requirements and variations in plant process flexibility, a single elasticity coefficient for all industrial use is probably unattainable. Research in this field appears quite limited. One small scale study, however, has been undertaken within Massachusetts and the results of this study are described in the following paragraph.

Coefficients of elasticity for water demand response to pricing changes were studied by Stephen J. Turnovsky.[2] This study was primarily directed to the question of the response of individuals to an uncertain supply of water. From data collected from a sample of Massachusetts towns, the coefficient of elasticity derived for household use was around 0.3, and for industrial demand, about 0.5.

b) <u>Application of Prior Study Conclusions to Eastern Massachusetts</u>

As described in the previous paragraphs, both Howe-Linaweaver and Turnovsky have developed equations and price elasticity based on empirical data which suggest the influence which pricing may have on demand. In an attempt to determine the significance of these relationships to current water demand in eastern Massachusetts, a computer program using these relationships was developed for communities serviced by the MDC.

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[1] based on a house market value of $20,000 and cost of water at 40¢/1000 gallons.

[2] Turnovsky, Stephen J., "The Demand for Water: Some Empirical Evidence on Consumers Response to a Commodity Uncertain in Supply," <u>Water Resources Research</u>, V, No. 2 (April 1969).

Once the computer program had been developed, a series of hypothetical price increases were imposed on the existing municipal rate structures. The effect of these increases on both domestic and in-house use and lawn sprinkling requirements are shown in the following table:

TABLE 9

Effect of Hypothetical Water Supply Rate Increases on MDC Demand,

Theoretical Decrease

| Price Increase ¢/1000 gals | Domestic Demand | Lawn Sprinkling Demand | Industrial[1] Demand | Total |
|---|---|---|---|---|
| 5 | 4.3 | 1.2 | 1.4 | 6.9 |
| 10 | 8.6 | 2.1 | 2.7 | 13.4 |
| 15 | 13.0 | 2.9 | 4.1 | 20.0 |
| 20 | 17.3 | 3.5 | 5.4 | 26.2 |
| 30 | 21.6 | 4.1 | 8.3 | 34.0 |
| 40 | 25.9 | 4.6 | 10.7 | 41.2 |
| 50 | 34.5 | 5.3 | 13.7 | 53.5 |

c) Discussion

As illustrated in Table 19, price adjustments would appear to offer an alternative to development of supplemental water supplies. Theoretically, a price increase of 50¢ per 1,000 gallons could be expected to reduce domestic or in-house demands by about 34 mgd and a corresponding decrease in lawn sprinkling demand by about 5 mgd. Industrial water use demands are indicated to react by decreasing almost 14 mgd. The total theoretical decrease on the system then with such a price increase would be about 53 mgd.

On the basis of the theoretical equations then pricing would appear to be a valuable tool for conservation of the water resource. A number of questions, however, arise concerning the direct application of these forecast decreased demands to the water supply situation at hand.

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[1] does not include partially serviced communities

First, the empirical data used in the derivation of the domestic use equations, although the most extensive to date is far from all inclusive. Data used was derived from 21 areas nationwide, which contained about 5000 dwelling units. None of the test areas were located within Southeastern New England, although data available from the Middle Atlantic States was used.

In the analysis of industrial water demand reaction data utilized was quite limited, and other research in this area is almost non-existent. Development of any hard policy conclusions based on such sketchy information is, therefore, uncertain at best.

Second, the derivation of the empirical equations for domestic use was based on a "static" view of cost versus use. That is, the data employed was not an observation of a group of communities actual reaction to pricing changes. Rather the equations were developed by using a number of communities, which for a given point in time, had different water use with their individual rate structures. For example, Community A in 1970 used 100 gpcd at a cost of 20¢ per thousand gallons; Community B in the same year recorded an average use of 50 gpcd at a cost of 40¢ per thousand gallons. Based on the approach used by Howe and Linaweaver, the expected decrease in use from Community A with a price increase to 40¢/1000 gallons would be 50 gpcd. Whether the use of such a "static" scenerio to predict dynamic conditions is valid is unknown.

That the equations may not indeed reflect the dynamic situation which would occur with a price increase is particularly suspect with actual operating experience in the Boston Region. For example, in the Boston Region, the MDC increased wholesale prices for its water from $40 to $80 per million gallons in 1954, and $80 to the current $120 per million gallons in 1962. Neither of these price increases was accompanied by a decrease in per capita demand on the system, in fact, demand increased on the system.

To further evaluate the dynamic impact of pricing in an actual operating experience, a survey was made of a privately owned water company which recently applied a 24¢ per 1000 gallons to its water rates. This rate increase raised the cost of water to the consumer from $1.00 to $1.24 per 1000 gallons. The two communities serviced by the company are principally residential, thus the rate increase based on the empirical equation should be expected to result in a demand decrease or, in any event, a decrease in the rate of increase. The company reports, however, that instead of experiencing a decrease in per capita usage, it experienced a 5 gpcd increase, an increase in excess of that reported in years prior to the price increase.

Based on the actual operating experiences of these utilities within Metropolitan Boston, it appears that any arbitrary adoption of the empirical equation as a forecast tool with respect to water demand carries a large degree of uncertainty.

Third, all of the studies upon which the pricing - demand relationship was developed have been basically economic studies. No attempts have been made to evaluate or quantify cost to the consumers from either environmental quality or social considerations. Nothing systematic is known about such losses, in spite of the widespread occurrence of drought and shortage in recent years.

Both the social and environmental costs of reducing water demand may outweigh the gains derived from institution of such a policy. Whether, in fact, the costs would outweigh the benefits is unfortunately unknown.

In summary, use of increased water supply prices as a method to conserve a resource may have merit. Yet to be determined, however, are data to support the theoretical impact such increases would have upon the demand within New England. Also unknown with this approach are the social and enviromental costs which would be borne by the consumer. It appears then that much work remains to be done on this approach, such that it can be evaluated as a viable alternative to increased supply.

### 3) Imposing of Restrictions on Water Use

Historically, water utilities have used water use restrictions as a "safety factor" against depletion of supply during a drought. In general, however, most water utilities attempt to avoid restrictions whenever practical. Public reaction to such restrictions, however, is almost always unfavorable, and many examples of such public disapproval can be found in newspaper clippings during the recent sixties' drought.

Imposition of restrictions on water use could not fail to interrupt the existing and planned life styles of communities serviced by a water supply system. As described in the appendix on socio-economic impacts, restrictions on water use, depending on its degree, would have far reaching social and economic costs. On the basis of costs which would be incurred with a restriction policy, it does not appear to offer a viable alternative.

4) Utilization of Water Saving Devices In-House

Much of the recent increase in municipal water supply by individual consumers has been attributed to the adoption of multiple toilet facilities; water using devices such as automatic clothes and dish washers; and shower installations. Variation in water use between brand names differ markedly. For example, automatic home washers for an 8 pound load require from 32 to 59 gallons per load, while toilets vary from 3.2 to 8 gallons per usage. Information on the impact of domestic water saving appliances on in-house use is limited and variable in quality.

An article[1] presented last year in the American Water Works Association demonstrated possible water savings which could be brought about by adoption of presently available appliances for toilet, clothes washing and shower use. In this article, the authors sought to determine whether the residential consumer would financially benefit by adopting the most up-to-date water using appliances. Varying replacement strategies as a function of costs were assumed. Based on their findings, the authors conclude that there doesn't appear to be current financial incentives for adoption of water saving appliances. They do note, however, that conversely economic costs to consumers from utilizing water saving appliances do not seem great. Presumably, their conclusion refers to replacement costs when currently used appliances wear out. The authors suggest that complete replacement of appliances with water saving models might reduce domestic water use by 32 percent.

A second study[2] of water conservation measures for the Office of Water Resources, U. S. Department of the Interior, also contains some information on water saving devices. In this study, it was noted that

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1 Howe, Charles W. and Vaugham, William J., "In-House Water Savings," Journal of the American Water Works Association, Vol. 64, No. 2, (February 1972).

2 Hittman Associates, Inc., "Main C. Computerized Methodology for Evaluation of Municipal Water Conservation Research Programs," No. HIT-409, Columbia, Maryland, August 1969.

increasing use of water by automatic dish and clothes washers over the years has been occasioned by a rise in required performance standards. Thus, customer desires are reflected in the increased water use.

A third study[1] recently completed for the Washington Suburban Sanitary Commission provides a brief review on the effectiveness of water saving measures and the relationship of their use to rate-making policy formulation. In this report, the authors state, "A major deficiency in the data reported by all investigators to date is that it refers to isolated uses of specific appliances and fixtures, but does not reflect actual use conditions. For example, reducing the water requirement of a toilet from 5 to 3 gallons per flush may be assumed to produce a corresponding decrease in water demand for that particular use. If the modification required to accomplish this reduction, however, interferes with the flushing action of the toilet, then the result may be an increased number of flushes which partially or completely nullifies the expected savings."

In reference to the suggestion that 32 percent of the domestic water use could be saved by adoption of water saving devices, the authors state, "Such a result implies, of course, no reduction in the actual or perceived efficiency of operation of any of the appliances or futures. In the latter instance, the net reduction in water use is more difficult to predict; however, it should be somewhat less than 32 percent."

Statements made at a number of progress meetings suggested that use of incentives such as subsidies or tax concessions and revision of plumbing codes to require water saving devices would result in substantial water savings.

In general, however, the same questions which burden analysis of price as a demand moderation measure also apply to use of water saving devices. Regardless of managerial technique used to implement use of such devices (i.e., subsidy, tax concessions, etc.) the question still remains as to the effectiveness and impacts on water use which may occur. Research conducted to date has been limited and supporting evidence to prove or disprove possible water savings is lacking. In addition, socio-economic impacts which might occur with a general requirement that older appliances be replaced with the water saving

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[1] Boland, John J., Hanke, Steve H., and Church, Richard L., An Assessment of Rate-Making Policy Alternatives for the Washington Suburban Commission, Prepared for the Washington Suburban Sanitary Commission, September 1972.

models has not been addressed at all. Environmental impacts generated as a spinoff of producing the new replacement models may also be significant and must be included in any analysis.

In summary, adoption of water saving devices as a method of conserving water supply may have merit in the long run. At present, however, supporting data to measure the impacts of either requiring new housing units or replacement by older housing with water saving appliances is not available. Without this data, evaluation of potential savings as an alternative course of action to the recommended project cannot be documented.

#### 5) Public Water Conservation Education Programs

Historically, the water supply industry has not advocated wide scale public water conservation, except in communities where supply or distribution systems were inadequate to meet demand. Recently, however, increased awareness of the need to protect and enhance the environment has required a review of this earlier policy.

At present, two[1] major metropolitan supply systems have adopted a water conservation policy during a time of water surplus. In the past year both utilities have promoted expanded voluntary customer water conservation through a public education program.

Bill inserts and information handbooks on water saving measures have been distributed widely. In addition, speeches to individuals, schools and clubs have been employed to inform the public of why the water resource should be used properly and what they can do to help conserve water. Results of the education programs are now being evaluated for their effectiveness.

The Washington utility which has the longest experience record reports results have been encouraging to date; however, major reductions in per capita usage have not been observed.

In addition to voluntary conservation measures, the two utilities are also considering the use of regulatory powers to conserve water. Regulatory measures under consideration include, for example, price increases, utilization of water saving household appliances and

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1 Washington Suburban Sanitary Commission and East Bay Municipal Utility District. Note: both utilities service populations of about 1.1 million each.

restriction of lawn sizes. All such measures, however, are being carefully evaluated by the utilities because of the many questions, described in earlier sections, which surround use of such devices.

In summary, adoption of public water conservation programs as a management tool has received attention of late. Results on water use modification of the voluntary conservation programs now under way are limited. However, based on the Washington area experience, no major decrease in per capita usage has been observed.

## Re-Examination of the Swift and Ware Rivers Downstream Release Schedules

At the time diversions were contemplated from the Connecticut River Basin, via the Swift and Ware Rivers, Massachusetts applied to the Secretary of War for authority to make the proposed diversions. After hearing arguments pro and con from Massachusetts and Connecticut, the Secretary permitted diversion of the flood waters of the Ware in excess of 85 million gallons per day between 15 October and 15 June and prohibited the taking of any water except during that period.

With regard to the Swift River, the Secretary permitted diversion of all waters of the Swift except enough to maintain a flow therein of 20 million gallons per day (mgd) or 31 cubic feet per second (cfs). The Secretary did require that during the period from 1 June to 30 November there shall be released from the impounding dam 71 mgd (110 cfs) whenever the flow of the Connecticut River at Sunderland, Massachusetts is 4650 cfs and 45 mgd (70 cfs), when the flow is more than 4650 and less than 4900 cfs.

These findings of the Secretary of War regarding operational schedules for the diversions were later made a part of the Supreme Court Decision, dated March 1931, in the suit between Connecticut and Massachusetts. Since the date of that decision, diversions from the Swift and Ware Rivers have been accomplished under the Secretary of War findings.

During the progress of the NEWS Study, an interested citizens' group suggested the setting aside of the Swift River diversion limitations with the objective of retaining presently scheduled releases within Quabbin Reservoir. The citizen group further suggested any diminution of flow in the Connecticut River could be made up by releases from existing

Corps of Engineers' flood control reservoirs. In keeping with this suggestion, an examination was made of the potential which such re-scheduling might have on the short-range supply problems.

The drainage area of the Swift River controlled by the Quabbin Reservoir totals 186 square miles. The long-term average annual runoff from the watershed is 187 mgd (289 cfs) of which 32 mgd (50 cfs) has been released downstream in compliance with the existing downstream release schedule.

Thus, the maximum addition to the existing water supply system which could be achieved through re-scheduling would be 32 mgd (50 cfs). To provide this increment, however, all downstream releases would have to be terminated. Such a complete cessation of downstream releases with the subsequent "drying up" of the river reach downstream is, of course, impracticable. The question then raised is what level is practicable. A recent study[1] completed for the entire Connecticut River Basin recommends an instantaneous discharge rate, from power reservoirs on the Connecticut River of 0.20 cubic feet per second per square mile of upstream watershed. An application of this criteria to Quabbin Reservoir, for example, would result in a downstream release requirement of 24 mgd (37 cfs). Adoption, then, of such a modified operational schedule could result in an additional 8 mgd being made available. This increment of yield, however, would not begin to meet the short-range needs of this report's study area which are estimated to total an additional 141 mgd. In short, then, a re-examination of downstream release schedules with the objective of conserving such releases for water supply has merit. However, based on the requirement of maintaining a viable river environment downstream from Quabbin, the opportunity for reducing downstream releases does not offer an alternative.

The spring runoff which occurred in 1972 was of longer duration and of greater magnitude than is usually experienced. As a result, diversions from the Ware River, in compliance with the operation schedule described earlier, were forced to cease even though flows in excess of 85 mgd were still occurring. This event triggered a suggestion to the NEWS Study that if the 15 June to 15 October no diversion constraint were lifted, large additional supplies of water could be made available to Quabbin.

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1 Comprehensive Water and Related Land Resources Investigation, Connecticut River Basin, Connecticut River Basin Coordinating Committee, June 1970.

A computer test was made to determine the impact of the 15 June to 15 October constraint. The results of the computer simulation indicated that only an additional 2.6 mgd might be made available if the 4 month no diversion period currently in effect was terminated.

In the Ware River, as in the case of the Swift River, a re-examination of downstream release schedules may have merit. However, terminating the 15 June to 15 October diversion period constraint does not offer an alternative.

## 6. The Relationship Between Short-Term Uses of Man's Environment and the Maintenance of Long-Term Productivity

Simply stated, the diversion of water envisioned by these projects would constitute a long-term use of some of the donor areas resources for the long-term productivity of the receiver area. The planning process, which included extensive engineering studies and an assessment of the biological and environmental data accumulated during the study period, did not uncover any irreversible actions or drastic effects on the area environment. It did, however, bring forth findings discussed elsewhere in this report which represent "trade offs" which are the alternates of two or more courses of possible action. Even by attempting to clearly delineate these points, it was found that words which have acquired a specific connotation in relation to the study become a major problem in interpretation. The phrase, "flood skimming" is a case in point. In its original sense, it was used to denote a course of action to divert water in the spring during the high flow period. It was as it has turned out, an unfortunate choice of descriptive words because it has led to an erroneous opinion that the total volume of the "flood waters" will be "skimmed." In actuality, for example, the Connecticut River under the proposals discussed in this draft would lose 2-3/8" of elevation at Montague City at the maximum diversion rate. This small loss in elevation would be unnoticeable to the casual observer.

The project as proposed would adversely effect the environment during the construction aspects. This would only be a temporary condition as the areas affected would be restored after the construction phase is completed. Regarding tunnel construction, the material to be excavated is believed to be clean and suitable for later use. These uses of our environment will serve to achieve the goal of this project, namely, an adequate supply of good quality water. The alternatives previously described, if and when implemented, would also serve this purpose, but would not prevent Quabbin Reservoir from deteriorating as Quabbin is used while these plans are implemented.

It is important that the quality of Quabbin Reservoir must be preserved not only for water supply but also for the diversified fish and wildlife resources which are found within. This we can all agree on, but the issue here is what is the best way. Is it by restricting the use of water, or by adding more water to Quabbin, or even some combination of the two? Conservation methods, if properly used and understood by the public and industry would certainly conserve water and prolong the lifetime of Quabbin. But would it be enough so that other sources of water could be developed? Diversion from the Connecticut River would prevent Quabbin from going dry in the next two decades, but would it degrade the present water quality or seriously disrupt the present equilibrium at Quabbin? These are the questions that have to be dealt with.

Studies to date have indicated that no serious problem would be created at Quabbin by the proposed diversions. With further pollution abatement programs along the Connecticut River and its tributaries, the water quality of the river will be further enhanced, thus the risk of degradation of Quabbin Reservoir due to diversions would be less. These studies have also shown that the estuary and areas downstream of the diversion sites would not suffer any great effects. If the diversions become a reality, additional studies will add to our knowledge and enable us to use our resources with the least amount of damage to our environment.

## 7. Irretrievable or Irreversible Commitment of Resources

All of the actions considered during the course of these studies would commit time and money. Further, structural measures would involve the commitment of materials to build the projects and would require the pre-empting of specific sites for other uses. Creation of weirs, tunnels, aqueducts and other fixed structures will commit these sites to long-term changes in present land use patterns. The precise extent of this commitment is unknown at this planning stage, but the impact can be minimized in the detailed project planning stage and by such tools as local land use and zoning. Nevertheless, although minor, it is a commitment to be recognized at this time.

Alterations to the landscape may also have an impact on those species of birds which pass through on their migration or remain to nest and raise their young. No known Endangered Species of birds or animals listed by the Fish and Wildlife Service utilize the proposed project lands. The amount of nesting habitat for migratory species will remain essentially the same in the region as it is at present.

Diversion of waters from the Connecticut River into Quabbin Reservoir represents an irreversible commitment. Once a diversion is made, there is no way to separate out the water diverted from the Connecticut River from the water already present at Quabbin. The same is true for diversions from the other proposed river systems. At any time, however, the diversions could be halted for health or environmental reasons. Thus, the decision to divert or not is reversible.

## 8. Coordination With Other Agencies

In November 1972, copies of the preliminary draft environmental statement were furnished to over 250 Federal, State, local and private agencies, organizations and citizens. With the end of the review period, approximately 40 agencies had responded, raising some 200 questions. Much of thettext has been revised in response to these questions.

Many different respondees raised similar points. To avoid any unnecessary redundency, this section has been divided into two parts. The first part deals with the more general issues, indicating where in the text changes were made in response to the various questions. The second part is the standard comment and response which deals with more specific questions.

### A. General

#### 1) Alternatives

The comments offered generally stated that the alternatives to the proposed diversions were not fully considered. As a result, the section on alternatives, section 5, has been expanded to include a greater discussion of the costs, impacts and rationale involved in each of the alternatives.

a) Desalinization

Many reviewers felt that desalinization could provide a long-term solution to the water crisis as well as an alternate source of water in the event Quabbin Reservoir or any other sources become contaminated for a period of time. This is true to some extent. Desalinization is a long term solution since once a plant is built it would continually be a source of good quality water. Nevertheless, desalinization would not satisfy the need for water in the near future (1976 - 1985 time frame). In addition, this alternative would create environmental problems (disposal of high temperature brine, large energy requirements) which the present technology cannot resolve. Desalinization could provide a water supply for the 1990 - 2020 time frame and will be given more consideration as the technology is further developed.

b) Waste-Water Reuse

Waste-water reuse is an alternative recommended by several reviewers as a way of conserving our dwindling water resources. The major concern here is for the public health and safety. Even after treatment, microchemical pollutants remain, some of which are toxic. Before being released to the general public, any treated waste-water should be thoroughly tested. The problem here is that the bacteriological tests take 24 - 48 hours before the results are ready while the tests for toxic chemicals take a few days. This means that the consumers could use the water before it is found safe unless the water could be stored at the treatment plant until all the studies are completed. Additional studies and monitoring are needed to insure that this method will be a safe source of water for domestic use.

To get an idea of the magnitude of the problem, in the USSR, health authorities have listed some 300 chemical parameters as drinking water standards with others under study, many of which were established on organoleptic grounds. In this country, only 20 parameters are used with nine serving as the absolute grounds for acceptance or rejection of a water supply.

2) Environmental Impacts

a) Downstream Effects on Connecticut River Ecology

One area of great concern to the reviewers was downstream effects on the salt - fresh water boundary at the estuary and on marine life dependent on this delicate balance. Section 3 - A1 discusses the impact of removing a part of the flood waters on the ecology of the estuary while the next section 3 - A2 deals with the mainstem of the Connecticut River. Both sections have been expanded to fully consider all aspects.

b) Control Flows and Downstream Water Supply

A concern was expressed by several people that the proposed diversions would remove water from western to eastern Massachusetts, thus creating the same and additional water shortage problems in the donor areas as predicted for the Boston area. This is not the case.

Throughout the valley, a large number of studies on future water supply needs and sources have been conducted. These studies include investigations by Federal and regional planning agencies as well as municipal level reports. In no case has any investigation indicated that the diversions under consideration would affect water supply plans by other potential users within the valley.

In 1960, community water supply requirements downstream from the proposed diversion intakes totaled about 159 million gallons per day (mgd). The recently completed Connecticut River[1] Comprehensive Study estimated this total to increase to about 575 mgd by the year 2020. Privately supplied industrial water requirements totaled about 253 mgd in 1960 and is estimated to increase to about 312 mgd by 2020 for areas downstream of the diversion intakes.

The 17,000 cfs control flow used in the diversion study on the other hand is equivalent to about 11,000 mgd in the river at Montague City and about 12,700 mgd at Thompsonville, Connecticut. Thus, the minimum river flow which must be in the river before any diversion would be allowed is far in excess of reported basin water supply needs.

The situation between those communities which would receive the diverted water and the municipalities in the valley is totally distinct. On the one hand, receiver communities are faced with distinct possibilities of water shortages. The valley communities, however, would not face water shortages because of the diversions. The adopted study minimum control flow requires a minimum flow of 11,000 mgd at Montague City, Massachusetts, before diversions would take place. This flow is thus available for valley needs. In order to place some measure on this available quantity of flow, it is again noted that in 1960, total municipal supply used in the valley downstream from the diversion projects was 159 mgd or about one-seventieth of the control total.

c) Biota and Non-Sport Fish in Connecticut River

This section discussed the presence of species considered to be objects of angling efforts for two reasons. One, information on fish populations readily available to the Corps is generally required by Fish and Game Departments whose interest, understandably, is with those populations of interest to the angler. Fishing information gathered by Massachusetts Fish and Game which was used in the preparation for Exhibit "R" required by the Federal Power Commission provided our base information. Note that in the Massachusetts Fish and Game comments attached, additional studies by them indicate that catfish are not important in this stretch of the river, and they do have some indication of possible walleyed pike spawning below Vernon Dam. Our second reason on citing

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[1] Comprehensive Water and Related Land Resources Investigation, Connecticut River Basin, June 1970.

sport fish is that, in general, they represent the top of the piscivorous food chain. Being so, their presence in the river indicates the biota below them in the chain is present in sufficient numbers to provide the base needed for their survival and to maintain a population. All of the fish cited can be classified as species which are successful in riverine situations if their individual requirements for temperature, dissolved oxygen, etc., can be met by the system. This is useful know as a riverine system is very unsteady when compared to the more relative stable conditions found in lakes and ponds. Temperature changes, rapid fluctuations in flows, seasonal and even daily changes are much more pronounced in a river. For a species of fish to survive in such an environment, they must be much more adaptable than those types generally restricted to ponds and lakes.

The following data has been taken from the Exhibit "W" prepared by Western Massachusetts Electric Company for their application to relicense their Turners Falls Project. This information, we believe, will assist in answering some of the questions raised about the presence of biota in the river other than the sport fisheries discussed in the draft.

Nest builders, such as the black basses and sunfishes are presently coping with the fluctuating water level in the pool and natural reproduction does not appear to be a factor limiting their abundance anywhere in the pool. The Project's operation in conjunction with the Northfield Project will increase the fluctuation in water level; but due to the configuration of the basin, the percentage of bottom alternatively covered and exposed will not be significantly changed. Before the operation of the Northfield Project, normal full pool had a surface area of 2,000 acres and a normal low pool of 1770 acres -- a difference of 230 acres. With Turners Falls Project and the Northfield Project operating at normal maximum, the full pool will have 2,110 surface acres and low pool will have 1,770 acres -- a difference of 340 acres. The percentage of bottom exposed in relation to surface area is not greatly different -- 12% compared to 16%. Therefore, the effect on habitat for nest builders and other fishes should not be deleterious.

In order to have the perspective of efforts made elsewhere to predict the effects of a pumped hydro plant on fisheries, it is useful to refer to a study [1] initiated by the Delaware River Basin Commission, which

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[1] Baren, C. F. - Limnological effects of simulated pumped-storage operation at Yards Creek 1971, Delaware River Basin Commission Report.

in 1967, 1968, and 1969 attempted to duplicate the effects of a pumped storage project on an aquatic biota through the use of test ponds. Test fish species were rock bass, blue-gill, pumpkinseed, large-mouth bass, walleye and yellow perch. The maximum diurnal draw-down tested was 3.5 feet.

Within the limitations of such simulations, the findings were reassuring regarding potential adverse effect. Nest builders produced somewhat fewer nests in the fluctuating water level ponds than in the control pond, but reproduction appeared quite adequate. Yellow perch and walleye also spawned successfully. While the control pond in these experiments produced more juveniles in one year, in that same year, two of the fluctuating level ponds produced more total weight of fish. To quote from the report:

> Conclusions
>
> 1. It was concluded that fish adapted to the uniform regime of water level fluctuations and were successful in spawning and hatching eggs. No unusual problems were apparent in the early development and growth of fish. The slight decrease in recruitment of fish observed in this study could be beneficial in most natural situations.
>
> 2. It was further concluded that the measurable effects observed in plankton and macroinvertebrate productivity, plant colonization, relative condition factor of fish, and physical and chemical properties of the test ponds had no marked effect on the fish populations therein.

Growth rate studies in the Turners Falls Pond show that all species, with the exception of smallmouth bass, grow fairly rapidly by Massachusetts standards. Smallmouth growth was about at the state average in 1964 but has decreased since. Scales from the 1964 Dingell-Johnson project were reread by the present study to provide consistency in this method of age determination.

To determine whether localized environmental factors might affect growth, comparisons were made between walleye, smallmouth and yellow perch taken at the various fish collection stations. Walleye and yellow perch show no apparent difference but smallmouth bass show slightly slower growth rate at the stations in the upper pool area.

Stomach analyses were made on walleye, smallmouth bass, yellow perch and largemouth bass. In general, the walleye is almost entirely piscivarous in feeding habits; the smallmouth diet is about 80 percent fish and during the summer a large proportion of the remainder is made up of various terrestrial insects; yellow perch utilize fish for about 95 percent of their diet with a strong preference for spottail shiner and their own young; the largemouth diet is about 97 percent fish with rock bass, bullhead and yellow perch being important items.

The picture that emerges from these food habit studies is of a game fish population that is supported primarily by a diet of other fish and with relatively little direct reliance on the benthic population. This would seem a normal situation in a run-of-the-river pond with a routine regime of fluctuating water level and an abundance and variety of forage fishes able to efficiently utilize the benthos, macroinvertebrates and plankton.

d) Construction Impacts

A number of agencies and individuals asked for more information on the impacts created by tunnel construction and disposal of the excavated material. These impacts are fully discussed in section 3-B7, Possible Environmental Impacts Caused by Construction.

e) Socio-Economic Trade-Offs

The analysis of socio-economic impacts was deemed as inadequate by several reviewers. The general feeling was that more consideration of these impacts in western Massachusetts and Connecticut was necessary. Accordingly, section 3-B9, Socio-Economic Impacts of the Projects on the Connecticut River Valley, has been added to rectify this situation.

f) Future Actions

The projects described in the impact statement are the only actions known to be receiving consideration. To meet any future needs, a number of other actions such as the development of the Merrimack River and conservation measures are also being considered. Therefore, the conclusion by many reviewers that future actions on the Connecticut River are inevitable is incorrect. When and if these other actions are developed further, environmental impact statements will be prepared to allow for input from all interested parties. Also, in the case of future diversions whether from the Connecticut River Basin or the Merrimack River Basin, before any action can take place enabling legislation by the states involved would be necessary. Prior to the passage of such legislation, an opportunity would be available for additional input by the public.

g) Definition of Wetlands

Because of the diversity of opinions in the correspondence received on exactly what constitutes a wetland, we have included the definition of the Bureau of Sport Fisheries and Wildlife (see their letter), and a definition developed by the Massachusetts Wetlands Research Project, administered by the University of Massachusetts, is included on the following two pages.

# A DEFINITION OF FRESHWATER WETLANDS[1]

Wetlands are those areas of land where water is so abundant that it is the major factor that dictates the nature of plant growth on the site. Relatively dry wetlands may have mature forests as the major vegetation, but the land surface is frequently flooded and the forests floor is covered with ferns and pocked with spring pools where few rooted plants survive. The most aquatic of the wetlands are the deep fresh marshes. These are shallow ponds where woody vegetation is sparse while water lilies and underwater plants are abundant.

Several systems have been devised to classify and name wetlands. The most broad and most widely used is that of the U. S. Fish and Wildlife Service (Martin et. al. 1953) which recognizes 20 wetland types. In the Northeast, and in Massachusetts, our study area, fresh meadows, shallow fresh marshes, deep fresh marshes, shrub swamps, wooded swamps and bogs are the common freshwater types. These are very broad categories and one portion of our research has developed a more detailed classification system better adapted to the Northeast (Golet, 1972).

## A Proposed Definition

With the advent of legislation restricting alteration of freshwater wetlands it becomes important to construct a formal definition of wetlands to ease application of the laws. Rhode Island and Connecticut have taken this step. We have combined these acts and added from our own studies to produce the following definition, retaining the legal style characteristic of legislative acts:

Freshwater wetlands include, but are not limited to, wet meadows; marshes; swamps; bogs; areas where groundwater, flowing or standing surface water or ice provide a significant part of the supporting substrate for a plant community for a significant part of the year; emergent and submergent plant communities in inland waters; that portion of any bank which touches any inland waters; and land, including submerged land, which consists of any of the soil types designated as but not limited to, very poorly drained by the National Cooperative Soils Survey, as may be amended from time to time, of the Soil Conservation Service of the United States Department of Agriculture.

Wet Meadows are places where ground water shall be at the surface for a significant part of the growing season and near the surface throughout the year and/or where a vegetational community shall be made up of, but not limited to nor necessarily include, all of the following plants or groups of plants: rushes (*Juncaceae*), sedges (*Cyperaceae*), hydrophytic grasses (*Graminae*), cattails (*Typhaceae*), bur-reeds (*Sparganiaceae*), water-plantains (*Alisma*), Arums (*Araceae*), Iris (*Iridaceae*), Dock (*Rumex*), Smartweed (*Polygonum*), false loosestrife (*Ludwigia*), purple loosestrife (*Lythrum*), loosestrife (*Lysimachia*), blue vervain (*Verbena*), boneset (*Eupatorium perfoliatum*), Joe-Pye weed (*Eupatorium dubium*).

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[1] This is extracted from *A Guide To Important Characteristics And Values Of Freshwater Wetlands In The Northeast*, edited by Joseph S. Larson, and to be available from the University of Massachusetts Wetlands Research Project, Spring 1973.

Marshes are places where a vegetational community shall exist in standing or running water during the growing season and/or shall be made up of one or more, but not limited to nor necessarily including all, of the following plants or groups of plants: Hydrophytic grasses (Gramineae), sedges (Cyperaceae), rushes (Juncaceae), cattails (Typha), pickerelweeds (Pontederiaceae), water plantains (Alismataceae), bur-reeds (Sparganiaceae), pondweeds (Zosteraceae), frog-bits (Hydrocharitaceae), arums (Araceae), duckweeds (Lemnaceae), water lillies (Nymphaeceae), water milfoils (Haloragaceae), water-starworts (Callitrichaceae), horsetails (Equisetaceae), naiads (Nayadaceae), buckwheats (Polygonaceae), arrowgrasses (Juncaginaceae), bladderworts (Utricularia), pipeworts (Eriocaulon), sweet gale (Myrica gale), buttonbush (Cephalanthus occidentalis).

Swamps are places where ground water shall be near or at the surface of the ground for a significant part of the growing season or runoff water from surface drainage shall collect frequently and/or where a vegetational community shall be made up of, but not limited to nor necessarily include all of the following plants or groups of plants: red maple (Acer rubrum), elm (Ulmus americana), black spruce (Picea mariana), white cedar (Chamaecyparis thyoides), ashes (Fraxinus), poison sumac (Rhus vernix), larch (Larix laricina), spicebush (Lindera benzoin), alders (Alnus), skunk cabbage (Symplocarpus foetidus), hellebore (Veratrum viride), hemlock (Tsuga canadensis), sphagnums (Sphagnum), azaleas (Rhododendron), black alder (Ilex verticillata), white alder (Clethra alnifolia), march marigold (Caltha palustris), blueberries (Vaccinium), buttonbush (Cephalanthus occidentalis), willow (Salicaceae), water willow (Decodon verticillatus), tupelo (Nyssa sylvatica), laurels (Kalmia).

Bogs are places where standing or slowly running water shall be near or at the surface during a normal growing season and/or where a vegetational community shall have a significant portion of the ground or water surface covered with sphagnum moss (Sphagnum) and where the vegetational community shall be made up of a significant portion of one or more of, but not limited to nor necessarily include all of, the following plants or groups of plants: blueberries and cranberry (Vaccinium), leather-leaf (Chamaedaphne calyculata), pitcher plant (Sarracenia purpurea), sundews (Droseraceae), orchids (Orchidaceae), white cedar (Chamaecyparis thyoides), red maple (Acer rubrum), black spruce (Picea mariana), bog aster (Aster nemoralis), larch (Larix laricina), bog rosemary (Andromeda glaucophylla), azaleas (Rhododendron), laurels (Kalmia), sedges (Carex), bog cotton (Eriophorum).

B. Comment and Response:

The following Federal and State agencies offered no comments in their replies to the preliminary draft:

U.S. Department of Agriculture, Soil Conservation Service
- Connecticut
- Massachusetts
- New Hampshire
- Rhode Island
- Vermont

Department of Housing and Urban Development, Region I

U.S. Department of Transportation, Federal Highway Admin., Region One
- Connecticut
- Massachusetts
- New Hampshire

Federal Power Commission

Office of Economic Opportunity

Commonwealth of Massachusetts
- Metropolitan District Commission

State of New Hampshire
- State Clearinghouse
- Water Supply and Pollution Control Commission

State of Rhode Island and Providence Plantations
- Statewide Planning Program

Correspondence received from these agencies are included as part of this final statement. The major points of the agencies comments are summarized below:

## U.S. Environmental Protection Agency

Comment: Turbidity entering Quabbin Reservoir should be kept low. Necessary monitoring should be defined and methods of controlling turbidity discussed.

Response: The importance of turbidity and its possible impact on Quabbin Reservoir was a consideration throughout the conduct of the study. To insure the acceptability of water delivered to Quabbin, the Northfield Mountain and Millers River Basin reports recommend the installation and maintenance of water quality monitoring stations. The location of these monitoring stations would be upstream of the diversion intakes and within Quabbin Reservoir itself. Both location, parameters to be tested and frequency of testing would be established by the Federal and State agencies who have responsibility in the safeguarding of public water supplies. Acceptance or rejection of water to be diverted during the life of the project would be determined by these responsible health agencies.

Comment: EPA agrees with Massachusetts Public Health directive that diverted water be chlorinated prior to entry into Quabbin Reservoir. Impact statement should include effectiveness of such water treatment and other treatment on diverted water.

Response: Water quality data collected as part of the NEWS reports indicates chlorination prior to entry of diverted flow to Quabbin Reservoir may be less effective than treatment applied to outflow water. Concurrence on this conclusion based on available data was made during the study by various Public Health Service engineers. Further water quality studies would be conducted during the Advanced Engineering and Design Phase of the projects. (The impact statement reviewed is for the planning phase of the projects). During the advanced engineering and design phase which precedes construction and operation of the project, the water quality data collected will reflect any improved or deteriorated upstream conditions. Utilizing this data as well as past background quality information, a determination can be made in consultation with responsible health officials as to the type of treatment required. If for example, chlorination is required based on existing river quality at that time, such facilities can be included in the design.

Comment: Pollution abatement plans for the Connecticut River are important in controlling the introduction of pathogens into the reservoir. The impact statement should indicate modifications that will be made if water quality is not found suitable for diversion in 1976.

Response: The NEWS study agrees that control of upstream waste discharges is necessary to protect water quality of the proposed diverted flow. The Environmental Protection Agency, in cooperation with the New Hampshire Water Supply and Pollution Control Agency and the Vermont Division of Water Supply and Pollution Control has established an implementation schedule for abatement of all point sources of pollution upstream from the Connecticut River intake. This implementation schedule calls for secondary waste treatment facilities to be construction and in operation by 1976. Established river water quality classification following implementation is Class B. Therefore, if the existing EPA-State implementation schedule is met, the NEWS study has no reason to believe the water quality would not be suitable for diversion.

Comment: Recommend the discharge of diverted water into the western branch of Quabbin Reservoir rather than the middle branch.

Response: The location of the outlet for the Northfield Mountain project has been a subject which received considerable attention during the NEWS study. Based on the studies conducted, the majority of investigations; including consultants, some Public Health Service engineers and Metropolitan District Commission Engineers; conclude that flexibility should be built into the outlet system. Accordingly, the outlet for the diversion would discharge into the middle branch of the reservoir. However, provisions would be constructed in the tunnel aqueduct which would allow extension of a tunnel leg to the west branch of the reservoir if it is found necessary. It is felt that the flexibility of this potential "Y" outlet arrangement as proposed allows greater protection for the reservoir than a single outlet location.

Comment: The project should include the use of a monitoring device to measure radioactivity. Concern is expressed about the possibility of an accidental spill during diversion periods.

Response: The NEWS study agrees that monitoring of water quality parameters in the water to be diverted is of paramount importance. As described in an earlier response both the Northfield Mountain and Millers River Basin reports recommend the installation and maintenance of water quality monitoring stations. The location, parameters to be tested and frequency of testing would be established with consultation by the responsible Federal and State health agencies. Such detailed investigations would be an element in the Advanced Engineering and Design Phase.

Comment: More detail should be included on the possible effects on fisheries downstream from the diversion projects.

Response: Possible effects of the diversion projects on downstream fisheries in the Millers and Connecticut Rivers and the Connecticut River estuary were studied extensively. Personnel from the U.S. Fish and Wildlife Service as well as private consulting firms provided input to the study. Impacts on fisheries in the estuary are included in Section 3 - Connecticut River Estuary Study. Impacts on fisheries in the Connecticut River from the diversions were considered by all investigators to be minimal. In the Millers River Basin, the control flows established and described in the statement were designed to have minimal impact on fisheries. Therefore, the diversions considered in the Millers Basin use as a baseline, flow rates which preclude impacts on downstream fisheries.

## Department of Commerce

Comment: It is not explicit whether the Millers River plans are included in the Connecticut River Diversion impacts given in Table 1 or in Figure 1.

Response: Text has been revised to clarify the inclusion of the Millers River plans in Table 1 and Figure 1.

Comment: In the discussion of public health aspects, mercury and pesticide analysis are not described consistently for the various alternatives.

Response: Text has been revised to insure consistent reporting.

Comment: Three comments were made on the section describing the potential of weather modification.

Response: Changes in text were made in accordance with comments .

## Bureau of Mines

Comment: Tunneling as proposed in the projects might have some impact on the mineral resource potential. The environmental statement should include a section on the geology of the region and discuss the impacts caused by construction.

Response: A section on the geology of the region has been included in Section II - Environmental Setting Without the Project. In Section 3, B7 Environmental Impacts of the Proposed Action, a discussion of construction activities is discussed.

## Bureau of Outdoor Recreation

Comment: The statement has largely failed to identify and assess recreation and open space related environmental consequences of the proposals and in particular the effect of diversions on the exhibt "R", a part of the application for Northfield Mountain submitted to the Federal Power Commission which covers the recreational resources associated with the project.

Response: We have carefully reviewed the exhibit "R" and find no points of conflict on recreation use of the Applicant's lands and associated waters with the diversion project.

Comment: The statement's discussion of the Millers River Diversion fails to specify if additional reservoir clearing or vegetation changes due to protracted inundation will have any adverse effect of recreational facilities at Tully Reservoir.

Response: As discussed on page 27 of the draft, the pool level would be held at 649 MSL between June 15 and September 15th for recreational purposes. Project operation includes summer recreational use of Tully Flood Control Reservoir.

Comment: The statement's references to transmission tunnels required for diversion do not provide sufficient detail to determine the environmental implications which might be associated with the construction or long-term operation.

Response: See Section III, B7 which discusses this point in detail.

Comment: The statement fails to consider the effect of supply rationing at present levels as a tool to stabilize interim growth of the region. The statement should be expanded to include discussion of the impact of such an alternative would have on prolonging the utility of the current water supply system.

Response: The reviewer apparently did not read the authorizing law which was included in the draft. No authority was granted under this legislation to plan for the stabilization of the region, the directive was to evolve a plan to meet the long term water needs of the northeastern United States. The directive is also discussed in some detail in the Introduction. Further discussion was included on page 150 of the draft.

## Fish and Wildlife Service

Comment: Established control flow rates should be referred to as estimates which may have to be adjusted where the project is implemented.

Response: True. The control flows are estimates, which may have to be adjusted. These estimated flow rates were worked out with Bureau of Sport Fisheries & Wildlife personnel during the Planning process.

Comment: Control flows should be discussed for Tarbell and Priest Brooks.

Response: Tables presenting control flows for all alternatives in the Millers River Basin have been added.

Comment: A glossary would be helpful.

Response: A glossary has been added.

Comment: A description of the existing; sport fishery from the estuary to Holyoke Dam; commercial fishing below Hartford and efforts to restore and enhance anadromous fish runs to the river should be added.

Response: The section on the Environmental Setting Without the Project - Northfield Mountain Diversion has been expanded to include the above aspects.

Comment: The Environmental Setting Without the Project should describe the historical fish and wildlife which were once associated with the Millers River. This section should also describe the potential for trout fishing in the basin with pollution abatement.

Response: The historical fish and wildlife attributes of the Millers River Basin have been added to the section. The possible environmental enhancement of the Millers Basin by pollution abatement measures have been described in Section 3 - Environmental Impact of the Proposed Action.

Comment: The section titled Environmental Impact of the Proposed Action should include possible impacts on the environment caused by construction activities.

Response: This is described in Section 3, B7.

Comment: Reference to requirement for fish passage facilities which bar lamprey eels and their subsequent impact on Quabbin should be deleted.

Response: References cited have been deleted.

Comment: Change definition of wetlands to read "Wetlands by their definition are lowlands covered with shallow and sometimes temporary or intermittent waters, and no significant impacts are expected."

Response: **Change has been made. See definition in General Responses, Section 8.**

Comment: Statement page 58 2nd paragraph should be changed to indicate that the environmental impacts on the Tully and East Branch Tully Rivers may be more significant than on the Millers River due primarily to differences in water quality and aquatic resources.

Response: **This has been done.**

Comment: The Tarbell Brook diversion discussion needs more consistency with the project description regarding pool size.

Response: Inconsistency caused by typing error which has been corrected.

Comment: Statement page 53, 3rd paragraph suggests rewording to read "Approximately 50 acres of valuable inland game habitat would be lost. Fishing and boating values associated with this project are expected to increase."

Response: Change as suggested made in statement.

Comment: Statement page 54, 1st paragraph, requests clarification of replacement of $\frac{1}{2}$ mile trout stream by marginal waterfowl area.

Response: Description as given in statement is sufficient to illustrate environmental impact of proposed action. No changes made.

Comment: Recommend that the list of adverse environmental effects be expanded to include destruction of fish and wildlife habitat and the environmental degradation resulting from urbanization (made possible) by delivery of this resource.

Response: Don't agree with this comment. This recommendation represents an opinion of the commenting agency. Although it may be debated that increased population in and of itself causes "environmental degradation" it does not follow that urbanization invariably causes environmental degradation. Changes in fish & wildlife habitat listed in the draft are those brought to the forefront by the Agency's representative during the planning process.

Comment: The water demand control section in the statement should include the impact of water conservation (assumed to mean education programs) for the public.

Response: The impact of public education programs on water use has been included in the statement in the Alternatives to the Proposed Action section.

Comment: The last paragraph of the Irretrievable or Irreversible Commitment of Resources Section is inappropriate and should be deleted.

Response: This section has been revised with the above mentioned paragraph deleted.

## National Park Service

Comment: Editorial nature.

Response: Changes made as suggested.

Comment: State Liaison Officer for Historic Preservation should be contacted to assure no sites being considered for addition to the National Register are affected.

Response: **Contact was made - no sites affected.**

Comment: Impacts caused by construction activities should be described.

Response: **See Section 3, B7.**

Comment: Long range potential impacts of diversion on the receiver and supplier area should be assessed.

Response: **Material requested is found in Section 3.**

## State of Connecticut
## Department of Environmental Protection

### General Response to Letter

The tenor of the questions relate more directly to the detailed information contained in the main Survey Report and appendixes. It must be borne in mind that the Environmental Statement cannot carry the detail of the main Report, its emphasis must be on Environmental imput.

The Department of Environmental Protection of the State of Connecticut in their reply to the Preliminary Draft Environmental Impact Statement stated the position that the project should be held up until a regional agency can be set up to determine the allowable amount of water that can be diverted from the Connecticut River and to allocate that quantity of water amongst the states in a mutually agreeable way. The Department of Environmental

Protection feels that the existing New England River Basins Commission could serve this purpose. In addition to their position statement, the Department of Environmental Protection also offered the following comments on the impact statement.

Comment: Section I is inadequate. The CEQ guidelines require that the EIS consider the overall cumulative impacts including future actions planned. The flood skimming is a precedent for future action.

Response: The projects described in the impact statement are the only actions known to be receiving consideration. To meet demands beyond the time frame served by the projects described a number of other actions such as development of the Merrimack River are inevitable is not concurred in.

Comment: It is unclear who would administer the water diversion with regard to minimum rates and days.

Response: This responsibility would be incorporated in the authorizing legislation for the specific project.

Comment: What will be the impacts of future action for which this is a precedent? Incremental amounts may injure the health of the river.

Response: See earlier response regarding future action.

Comment: Why was 17,000 cfs chosen as the lower limit of flow acceptable for skimming. The department feels a much broader and greater number of flow levels should be evaluated.

Response: See General Response - Control Flow, Downstream Effects.

Comment: What costs will be associated with the greater concentration of pollutants in Connecticut caused by diversion.

Response: Major pollution load enters Connecticut River below diversion point.

Comment: From a water supply standpoint what will happen to Hartford when they have to use Connecticut River water.

Response: See General Response - Effect on Connecticut River Basin Water Supplies.

Comment: What are the source data for the costs on the no go option.

Response: Reference has been added to No Action Alternative.

Comment: No Action Alternative considered only losses not benefits.

Response: The section on alternatives has been expanded to include greater discussion of this aspect.

Comment: Desalinization is a long term solution which was not considered fully.

Response: See Section 5 - Alternatives - Desalinization which has been expanded from the draft.

Comment: Waste water as a potential source of industrial water is not sufficiently developed.

Response: Section on waste water reuse has been expanded. Also see General Response - Alternatives - Waste Water Reuse in Section 5.

Comment: No cost/benefit figures were presented.

Response: Cost figures have been added.

Comment: Insufficient information on costs and benefits were given.

Response: It is felt data of sufficient detail was presented which allows an assessment of this alternative.

Comment: Other diversion sites on the Merrimack and Sudbury systems does not adequately present cost/benefits.

Response: Section has been rewritten.

Comment: Water user data is inadequate. Estimates of water savings; from waste reduction, educational, modifications of building codes and pricing elasticity should be investigated.

Response: The types of investigations stated are included in the NEWS report as concurrent recommendations to project implementation. (Also see Section 5)

Comment: Since the Corps is involved with federal funding, some alternatives may be chosen not because they are the best, but because outside funding is available only for certain options. Which of the alternatives presented would the Corps help finance and which ones not?

Response: The legislation which initiated the NEWS study did not place any restrictions on alternatives which could be considered.

Comment: The restriction alternative was not fully developed. Growth has costs as well as benefits.

Response: The section on alternatives has been expanded in this area.

Comment: The population zoning and regulation definition and analysis is inadequate.

Response: Sufficient information is presented to show this is not a viable alternative to meet the 1980 time frame.

Comment: Donor and receiver areas are in Massachusetts, but any damage to the river would occur downstream. A cost/benefit analysis should be presented.

Response: None of the investigations conducted indicated any downstream damage.

Comment: The department feels these diversions are an irreversible commitment of future diversions from the river basin since no ceiling has been determined for the river.

Response: See earlier response regarding future action.

## Massachusetts Department of Commerce and Development

Comment: Recommends that additional emphasis be placed upon the beneficial economic aspects of any of the alternatives.

Response: The main report of the NEWS studies include a major section on Project Impact Analysis in which two of the accounts used are National Economic and Regional Development Ovjectives. The impact statement has been modified in the no Action Alternative to more fully describe the implications of this alternative. In addition costs for all alternatives have been added.

## Massachusetts Division of Fisheries and Game

Comment: The summary sheet should qualify that no adverse effects are predicted for the mainstem of the Connecticut River and its estuary based on a control flow of 17,000 cfs.

Response: Control flow in the Connecticut River used in the report has been included in the discussion in Section 3A, 1 & 2.

Comment: The Fish and Game Department anticipates diversion will cause significant changes in fish populations and abundance at Quabbin Reservoir.

Response: No back-up data is furnished to support this opinion. We have included their statement in the appropriate section of this revised draft.

Comment: Bull heads are not considered important sport fishes in the Connecticut River in the vicinity of Northfield Mountain while yellow perch not listed in the statement are important.

Response: Reference to bullheads deleted and yellow perch added.

Comment: Catfish, based on state studies, is not an important species to anglers in the river reach under discussion.

Response: Deleted reference to catfish.

Comment: Recent studies indicate walleye may spawn in the river reach below Vernon.

Response: Reference to possibility of walleye spawning in river reach under discussion is acknowledged.

Comment: No known fish passage facilities can effectively stop migration of lamprey eels and if introduced to Quabbin, the eels could be positively controlled.

Response: Reference to requirement for fish passage facilities which bar lamprey eels and their subsequent impact on Quabbin have been deleted.

Comment: Fish and game division does not agree that "diversion into Quabbin Reservoir presents a possibility of having a negative ecological impact on the fisheries of Quabbin". They feel a significant ecological impact will eventually result.

Response: We believe our negative and their significant mean the same thing.

Comment: Reference to studies on methods of excluding undesirable species being carried out by the MDC in cooperation with the Massachusetts Division of Fisheries and Game are in error. The Fisheries and Game Division has only discussed the feasibility of such studies.

Response: Statement will be modified to reflect current agreements between the MDC and the Division of Fisheries and Game.

Comment: It is believed that a decrease in oxygen in the hypolimnion will have a profound effect on the lake trout population which is part of the present ecology of Quabbin.

Response: The magnitude of the decrease in oxygen in the hypolimnion is not expected to be such as to effect salmonoid fish. Localized depletions of oxygen have been noted in Quabbin over the past six years. This year a 17 lb. lake trout was caught in Quabbin, indicating that past depletions have not been harmful to lake trout.

Massachusetts Agricultural Experiment Station

Comment: Only minute amounts of pesticides are soluble in water. Most of it is absorbed on particulate matter and subject to sedimentation. Therefore, it is not quite agreed that evaporation can be taken as a means to remove hydrocarbon pesticides through co-distillation.

Response: Text in question has been revised to read "Finally, many highly insoluble organic materials, including hydrocarbon pesticides and organomercury compounds, which are not absorbed on particulate matter and settle out, would tend to evaporate, as they reach the relatively large surface area of the reservoir."

Commonwealth of Massachusetts
Water Resources Commission

Comment: The section discussing mercury levels is unclear because it follows references to mercury levels in fish with references to levels in water.

Response: Section has been clarified.

Comment: Reference to the potential of Quabbin drying up should be expanded to include assumptions made.

Response: Assumptions have been clarified.

Comment: The section regarding the cleansing action of high flows is unclear.

Response: Section has been rewritten.

Comment: Reference to implementation of the Tully system with regard to Quabbin Reservoir might better read Millers basin diversions.

Response: This section has been rewritten to reflect impacts of the Northfield Mountain and the preferred Millers Basin projects.

Comment: Perhaps you should explain why 12,000 cfs was chosen as one of the control flows.

Response: The 12,000 cfs value together with the wide range of diversion rates tested was intended to provide sufficient testing points such that a measureable impact could be obtained. An explanation of this rationale has been added to the statement.

Comment: Is it anticipated that shad would migrate upstream more rapidly to compensate for the 3± day difference in spawning maturity development?

Response: See page 85 of the draft. Explains that studies conducted under worst possible conditions (12,000 cfs at Montague City and 4,000 diversion) indicate a maximum temperature rise of .61°F. This is too small to be biologically significant so a hypothetical 2°F was used as a yard stick as explained on this page. Page 86 discusses shad migration and temperatures and the fact that they go further upstream during "colder" spring. The consultant has postulated that the most severe diversions would have an insignificant effect on shad spawning locations.

Comment: How does egg development data correllate with effect on spawning described in the statement.

Response: This is described on page 86 in the draft and is contained in this statement.

Comment: Alewives are not mentioned. Alewives and blue backs are presumed to fast as they run upstream to spawn and resume feeding when the spent fish return to brackish water.

Response: Concur.

Comment: Temperature rise is given as 72°F.

Response: Typographical error. Corrected to 2°F.

Comment: The statement relative to additional sources of heat should be qualified to conform to existing Water Pollution Control standards which relate to most sensitive use.

Response: Paragraph cited relates to one of the three assumptions which had to be made so it could be possible to calculate the changes in temperature caused by varying diversions. The paragraph has no relation to Water Pollution Control standards.

Comment: Does temperature rise of 20.4°F refer to effluent temperature above ambient or actual increased temperature of receiving waters.

Response: Reference is to temperature above ambient.

Comment: Text should include a map illustrating relative locations of Thompsonville and Bodkin Rock.

Response: Because of the scale involved, a written description has been added in lieu of a map.

Comment: "A cleaner river than otherwise possible..." might be changed to otherwise likely.

Response: This section has been rewritten and the subject sentence was not included in the rewrite.

Comment: Percentage of flow diverted from the Millers River should be included.

Response: Percentage diverted has been added.

Comment: Justification is needed for the statement that at some point in the future river water may be of better quality than Quabbin Reservoir.

Response: This statement is based on the degradation in reservoir water quality which may occur with a heavily depleted volume. If the reservoir water was degraded and river water quality improved through construction of waste treatment facilities then the river quality could be better than the reservoir's.

Comment: Alternative population trends should be exmained for their impact on projections used for the projects in the statement.

Response: Recent population estimates prepared by the University of Massachusetts were compared to estimates used in the NEWS study. For the eastern Massachusetts counties of Worcester, Essex, Middlesex, Suffolk, Norfolk, Bristol, and Plymouth there was close agreement in the population total for 1990. Deviations between the estimates was 1% in 1990 for the eastern Massachusetts region. (the general service area of the projects).

Franklin County

Comment: The impact statement indicates a variety of undesirable influences will be added to Quabbin Reservoir. The statement also notes that monitoring will be performed. However, it is impossible to believe the project would be terminated if permanent damage were recorded by the monitoring.

Response: The impact statement does describe some negative impacts which may occur within Quabbin Reservoir because of Connecticut River inflow. The possible impacts described, however, must be judged in the light of water quality loss without diversion. The monitoring programs anticipated would provide a continuous check on conditions within the reservoir. If deleterious affects were observed within the reservoir additional remedial measures could be undertaken. It must be remembered that all impacts described in the statement are based on existing Connecticut River quality conditions. Proposed waste treatment plants currently included in the Federal-State implementation schedule plus the goals set forth in the Water Quality Act of 1972 will considerably improve conditions over those presently found in the river. Therefore, any possible impacts included in the statement should be minimized by the waste treatment facilities.

Comment: It is implied in all environmental legislation that quality environments should be preserved and less than desirable environments should be upgraded to meet the optimum. The impact statement defines possible impacts which could have a deleterious effect on Quabbin Reservoirs existing high quality. This is violating the intent of the environmental movement. A better solution is to utilize poor quality sources through upgrading.

Response: The reviewer perhaps missed the portion of the draft which indicates that at current use rates Quabbin would be in trouble as a "treatment plant" before it would be unusable as at water supply. It is essential that water be introduced to keep up its purification capacity.

Comment: Sport fisheries are used as the only criteria of environmental influence. Food chains which support the fisheries are not considered.

Response: See General Responses - **Biota and non-sport fish.**

Comment: The "report" indicates that Tully Lake will be doubled to 600 acres (Alternative No. 3 only) and used as a domestic water supply. Does this mean swimming will not be allowed? Franklin County could use additional surface water recreation activities.

Response: Correspondence received from the Massachusetts Department of Public Health notes that full recreation activities would be allowed on the impounded pool.

Comment: A fine case is made for socio-economic impacts on receiver communities. However, a similar analysis of negative impacts was not made for basin communities.

Response: Investigations conducted did not reveal widespread impacts on the basin communities as suggested by the reviewer. The section on socio-economic impacts for the basin communities has been expanded to clarify this point.

Comment: A local community, namely Orange, Massachusetts is approaching the limits of its presently available safe yield. Why wasn't this town and other basin communities provided access to the water system.

Response: The future needs of the communities in the basin was compared to available resources before any diversions were contemplated. Based on these investigations local resources are available (even after diversion) to meet their needs. In the specific case of Orange, both surface and ground water resources are available which can be developed at far less cost than connection to **Quabbin Reservoir.**

Comment: Athol and Orange have high unemployment rates and their overall welfare and economy are in serious trouble. If it is assumed that water supply is a resource needed to promote future growth what is the overall long term impact of removing the resource.

Response: Projections of economic growth in the subject region were prepared. On the basis of these projections the diversion projects would not affect growth potential.

Comment: Why is there no mention in the Environmental Impact Statement of a mechanism to allow the doner area to gain back the complete right of using the water resources considered in the projects.

Response: The intent of the environmental impact statement is not to act as a summary of the main study reports and thus this item was not included. However, before the Millers River Basin project was implemented enabling legislation by the Commonwealth of Massachusetts would be required. The issue raised by the reviewer probably would be considered prior to the passage of such legislation.

Comment: The question of who pays for the project is unanswered. The MDC is a state agency and therefore will the costs be allocated to the consumers or all the residents of the state?

Response: As described in the response to the prior comment enabling Massachusetts legislation would be required. At present consumers of MDC water pay all costs of the system.

Comment: As a trade off, increased recreational use of Quabbin reservoir should be allowed.

Response: The Massachusetts Department of Public Health is the responsible agency regarding recreational use of water supply reservoirs. Any additional recreation activities would have to be sanctioned by that agency.

Comment: The impact statement indicates ground water development is too costly. Costs are not given in the statement, however.

Response: Costs have been added.

Comment: What are the water demands for the Connecticut River Valley area and have they been taken into consideration?

Response: See General Response - Effect on Connecticut River Basin Water Supplies.

Comment: What will be the effects of tunnelling on the environment?

Response: See General Response -(Environmental Impacts of Construction Activities?)

Comment: The projects would add a resource which would allow further growth in urban areas. As a consequence Franklin County is developing into a recreational area for those in urban areas. This recreation industry is not wholly desirable and reduction of available water resources will further guide the county into a single economic system.

Response: See earlier response regarding water supply and economic projects.

City of Hartford

Comment: Opposes proposed diversions until riparian rights of the city have been recognized and provided for through adequate institutional arrangements representing jurisdictions having rights and interests and also until the implications of the proposed diversions with respect to ecological effects and future water supply needs in areas downstream have been more adequately studied and considered.

Response: Opposition statement has been included in impact statement.

Town of Montague

Comment: Diversion from the Tully Flood Control Dam and/or Tully Complex would seriously deteriorate water quality in the Millers and Connecticut Rivers.

Response: Impacts of diversion on water quality has been expanded in the statement.

Natick Conservation Commission

Comment: The statement does not offer alternative actions for resolving the real problems of water resource supply and demand. The NEWS study should work for waste-water reuse; local ground and surface water resource development; local water pollution treatment; water rate changes; programs to modify domestic plumbing; increased rates by the MDC; and use of the Merrimack River and tributaries.

Response: Alternative actions are included in Section V - Alternatives to the Proposed Action. These alternatives are given in the NEWS studies' recommendations. In addition to project implementation programs designed to educate and investigate advantages and disadvantaaes of water conservation techniques are recommended.

Connecticut Audubon Council Inc.

Comment: The comments offered by this reviewer indicate that in their opinion certain areas of the statement are not sufficiently detailed.

Response: This Final Statement has amplified the draft material and includes additional data for the greater detail requested by this and other reviewers.

## Connecticut Forest and Park Association, Inc.

Comment: The draft statement fails to recognize the need for a more detailed analysis and evaluation of these and other diversions within and without the watershed of the Connecticut River.

Response: Statement represents an opinion of the reviewer.

Comment: We have concerns relative to the possibility of the diversions at Northfield and the Millers River Basin Water Supply Project being viewed by the Metropolitan District Commission as a justification for additional diversions from these and other tributaries of the Connecticut to meet other needs within the service area of the Commission beyond 1998.

Response: See General Responses - Future Actions

Comment: A disproportionate emphasis has been placed on the negative aspects of no diversion, while positive alternatives of placing reasonable limits on consumption and moving toward re-use of water in the industrial sector are de-emphasized.

Response: See General Responses - Alternatives

Comment: The examination and analysis of potential ground water supplies in Plymouth County appear to be incomplete. Economic and social cost are referred to but they are not completely analyzed. Desalinization is treated in a similar manner.

Response: The entire section on alternatives has been rewritten to present a clearer picture of the pros and cons associated with each alternative. See General Responses - Alternatives.

Comment: The statement on page 156, "... that both donor and receiver areas are within the borders of Massachusetts, so that economic benefits realized by the construction of the project would be reflected favorably on the state's economy as a whole." is fallacious.

Response: The above mentioned statement has been deleted and the section in which it appeared has been rewritten.

Comment: The diversion projects have been predicated upon a control flow of a minimum of 17,000 in the Connecticut River at Montague City. This control flow was elected not from environmental considerations but rather from existing Massachusetts State legislation which was based solely upon the hydro power generation needs at Turners Falls Dam.

Response: The control flow on the Connecticut River for the various diversion projects is specified in the existing Massachusetts Legislation relative to the Northfield Mountain project. Adoption of a control flow other than that specified by the Commonwealth of Massachusetts would be unrealistic planning. However, environmental impacts of diversions utilizing this control flow were thoroughly investigated. Examinations were made of possible environmental impacts on the Connecticut River estuary, on the river system downstream from the project intakes and on the receiving water bodies. The evaluation of possible impacts demonstrates clearly that use of the 17,000 cfs value insures minimal environmental degradation. Thus, if use of the 17,000 cfs figure as a control insures minimal environmental damage, it follows that some lower value, in fact, would be an environmental control flow rate. Use of the existing legislated minimum control flow thus provides a conservation approach to planning.

Comment: Increased water flows are being considered by the Federal Power Commission in relicensing of Turners Falls and the four immediate upstream dams (currently an additional 0.20 cfs per square mile of drainage.) it would be consistent in the Corps of Engineer's thinking to make these flows available for diversion under the current method of stream flow calculation.

Response: This comment is apparently caused by the Council's lack of understanding of the relicensing under consideration and of the Connecticut River's hydrologic cycle.

Modifications of existing flow rates are being considered by the Federal Power Commission (FPC) in relicensing of Turners Falls and the three (not four as stated) immediate upstream dams. The 0.20 cubic feet per second (CFSM) currently under consideration by the FPC in its relicensing deliberations is not an additional amount over and above those flows presently found in the river during the entire year. Rather, the 0.20 cfsm refers to maintenance of an instantaneous minimum flow rate below the power dams.

At most times of the year, flow conditions in the river exceed the 0.20 cfsm value. During low flow periods, however, operation of the power dams causes river flow to fall below this value on occasion. The FPC thus is considering relicensing the subject power dams with the stipulation that their operation insure a minimum 0.20 cfsm flow at all times, even during low flow periods.

The diversions being considered, on the other hand, would take place during high runoff periods when river flow below the power dams is far in excess of the 0.20 cfsm value. For example, the 17,000 cfs control flow used throughout the study would allow a minimum of 2.2cfsm flow downstream of the Turners Falls power dam. Thus, the planning under way for diversions and deliberations by the FPC on relicensing are fully compatible.

Comment: The Council has questioned whether there exists a "substantial surplus of water." It further states that the availability of water and the future demands for water supply have not been fully studied or planned for.

Response: See General Responses - Effect of Diversions on Connecticut River Valley Water Supplies.

Comment: It is assumed that identical impacts may occur within the donor if diversions are allowed as has been suggested to occur in the receiver area if diversions are not allowed.

Response: The situation between those communities which would receive the diverted water and the municipalities in the valley is totally distinct. On the one hand, receiver communities are faced with distinct possibilities of water shortages. The valley communities, however, would not face water shortages because of the diversions. As stated earlier, the adopted study minimum control flow requires a minimum flow of 11,000 mgd at Montague City, Massachusetts before diversions would take place. This flow is thus available for valley needs. In order to place some measure on this available quantity of flow, it is again noted that in 1960 total municipal supply used in the valley downstream from the diversion projects was 159 mgd or about only one seventieth of the control total.

In the evaluation of the project impacts, possible socio-economic impacts were assessed for the valley communities as well as for the receiver communities. The results of this investigation are summarized in the Preliminary Draft Environmental Impact Statement.

Comment: Cost estimates of ground water development should be given. More evaluation should be given to this alternative.

Response: Costs have been added and the section on ground water development expanded.

Comment: Impact of construction activities are not described.

Response: See General Responses.

Comment: More study needs to be done of alternative water supply sources in eastern Massachusetts and further environmental impact studies are needed.

Response: Further study on any issue may aid the final decision. It is felt however that sufficient study has been conducted such that a rational decision may be made on the projects under consideration.

Lower Pioneer Valley Regional Planning Commission

Comment: Use of the 17,000 cfs control flow rate is a questionable standard in light of its basis in power generation needs rather than environmental criteria.

Response: See General Response - Control Flow

Comment: Concern is expressed as to the manner of monitoring diversions.

Response: The provision of adequate gaging stations to measure diverted flow would be included in any of the alternative projects. The location of such stations would be part of the advanced engineering and design investigations.

Comment: No specific flows are proposed for Alternatives No. 1 and 3.

Response: Tables showing control flow rates have been included for all alternatives.

Comment: Should not the August, September and October control flow be maintained at no lower level than that proposed for July.

Response: The flow rates shown were developed in conjunction with the U.S. Fish and Wildlife Service and represent those values considered necessary for maintenance of the stream's fisheries resource.

Comment: Socio-economic benefits to the supplier area must be weighed against costs. Diverted waters would not be available for use by communities of the donor area. Curtailment of water supply development caused by diversion by valley municipalities may result in socio-economic problems.

Response: See General Responses - Effect of Connecticut River Basin Water Supplies.

Comment: No clarification is given as to the types and amounts of compensation that would be offerred the reparian communities.

Response: See General Responses - Effect on CRB Water Supplies.

Comment: Development of ground water supply sources in eastern Massachusetts holds promise. The statement however does not include costs.

Response: A fuller description of economic, socio-economic and environmental costs associated with ground water has been included in the statement.

Comment: Cost data given for desalinization should be documented further.

Response: See General Response - Desalinization.

Comment: A graduated water pricing system could have significant effect on demand especially for industrial users, i.e. through increased use of recycling.

Response: As described in the section on water demand control pricing for conservation objectives in the long run may have merit.

Comment: The statement lacks reference to the recently completed Connecticut River Comprehensive Study. There is no indication of how the diversion proposals fit in with this important study of the Connecticut River itself.

Response: Reference to the Comprehensive study has been added as follows: "All alternatives described were included in the 1980 Connecticut River Basin Plan prepared by the New England River Basins Commission."

## Massachusetts Audubon Society

Comment: There is no program set forth in the Preliminary Draft Environmental Impact Statement which advocates an integrated program of water supply expansion and demand limitation as the means to a long term solution.

Response: It appears from the comment that the impact statement was considered to be the **Report** on the Northfield Mountain and Millers River Basin water supply projects. The objective of an environmental impact statement is not to act as a summary of conclusions and recommendations for a plan of action. Rather the environmental impact statement's intent is to bring together and report upon the direct and indirect environmental impacts of a project and alternatives in a separate document. Alternatives to the proposed action in turn are assessed in the context of the definition of alternative i.e. one or the other not both. **To directly answer the question, yes, we recommended in the Reports that both the need for project implementation and for investigations to test methods of demand modification be carried out.**

Comment: No cost estimates are presented for treatment facilities yet benefits for the clean up of the Millers River are presented.

Response: Cost estimates have been added to the statement.

Comment: Socio-economic impacts are used in the report to favor the structural approach and to damn non-structural approaches.

Response: The assessment of potential socio-economic impacts under the "go" and "no go" (or with or without adequate supply) was made by a professional consulting firm under contract to the Corps of Engineers. The charge to the consulting firm was two fold:

1. Identify changes attendant on the Northfield and Tully diversions that will affect human populations in the immediate supply area and among potential receivers.

2. Quantify or characterize those changes wherever possible in terms of magnitude, direction and duration.

Comment: Cost estimates for ground water development in Plymouth County are not given.

Response: Costs associated with ground water development have been added.

Comment: Ground water recharge, waste water reuse and the elimination of leaks were not seriously investigated.

Response: Ground water recharge was investigated and not considered a viable alternative to the proposed action. Waste water reuse is described in Section 5 - Alternatives to the Proposed Action - Waste Water Reuse as a Municipal Supply. The possible impacts of a public education and conservation program have been added.

Comment: The preliminary draft demonstrates a remarkably discretionary use of caution.

Response: This comment represents an opinion of the reviewer.

Comment: A reasonable assessment of the impact of the diversion on intermittent wetlands would be necessary in an honest statement.

Response: Stage reductions caused by diversions and impacts on "intermittent" wetlands has been expanded.

Comment: The impact of the diversion must be added to flood stage reduction by the existing system of flood control structures.

Response: The impacts tested and described in the statement represent impact extremes. If diversion impacts were considered at a time when flood control facilities were operating the impact would be even less. For example, flood flow rates on the Connecticut River at Montague City are 79,000 cubic feet per second. If the Northfield and Tully Millers diversions were operating at the same time, stage reductions would be about .2 feet. Temperature increases in the estuary under these flow conditions would be about 0.2°F.

Comment: Non-game aquatic species are considered insignificant. Each of these species is part of a complex food web. So in reality, the interrelated assemblage of populations of such species of fish and the eco system which supports them must be considered.

Response: See General Response - **Biota and non-Sport Fish in the Connecticut River.**

Comment: The draft statement fails to describe any analysis of the impact anticipated in coastal marsh areas at the mouth of the estuary which, because of reduced freshet flow, fail to experience the reduction of salinity which is natural at freshet time.

Response: No significant impacts are anticipated in the coastal marsh areas at the mouth of the estuary. The reviewer apparently has the misconception that operation of the diversions would cause a cessation of freshet conditions in the estuary. Freshet conditions in fact would not be halted.

Comment: There is a tendency to downgrade or neglect ecological disbenefits of the proposed diversions. For example, additional fertilizer will be necessary to compensate for the loss of the annual spring flood soil enrichment; loss of biological productivity in the estuary; damage to the Quabbin fishery; loss of recreational canoeing opportunities.

Response: Possible disbenefits are not neglected. However, the minor impacts, for example, expected on downstream flood plains (less than .1 foot stage decrease at Thompsonville) do not make a case for any substantial disbenefits. In the case of canoeing opportunities affected on the Millers River, this section has been expanded. The possible introduction of exotic species to Quabbin Reservoir appears to have been overemphasized in the preliminary draft based on statements made by the U.S. Fish and Wildlife Service and the Massachusetts Division of Fisheries and Game.

Comment: The statement fails to consider the cumulative effect on Connecticut River flood stage of the proposed diversions combined with existing diversions and flood control reductions.

Response: As stated earlier the impacts described are considered for severe conditions. During flooding conditions when flood control structures would be operated, impacts are less than those described. In addition the effects as described are based on hydrologic conditions which include the existing Quabbin and Ware diversions. Therefore the impacts as described do in fact reflect the cumulative effect.

Comment: The authors of the preliminary statement seem to be operating on the implicit assumption that all economic growth is good.

Response: In the evaluation of all of the projects, the proposed Water Resources Council guidelines were followed and benefits as well as losses were evaluated on a three account system. The guidelines were established under the premise that the overall purpose of water and land resource planning is to reflect society's preference for attainment of the three objectives defined as:

1. To enhance the National Economic Development.

2. To enhance Environmental Quality.

3. To enhance Regional Development.

Comment: Loss of municipal revenue is not a valid measure of economic loss. This would be true only if the community is able to operate its water supply system at a net profit.

Response: A community would not have to be operating at a net profit in order to sustain economic losses from water shortages. A water system is made up of many components which must be paid for regardless of the volume delivered. For example, distribution systems which were financed by municipal bonding represent a fixed cost to the community through amortization of the bonds. If revenue from water sales is not available to pay these costs there, the municipality must transfer funds from some other part of its budget. In turn money transferred is no longer available for other municipal services.

Comment: A diversified program provides a more desirable solution than simply project implementation.

Response: See earlier response on purpose of the environmental impact statement.

Comment: A fair market value for the water diverted should be paid for by the consumers. It is certainly a violation of equity that communities in the MDC area resell Quabbin water to support their tax basis at the expense of communities along the Connecticut.

Response: It is a debatable point that consumer communities support their tax base at the expense of communities along the Connecticut. However, throughout the conduct of the NEWS study, equity has been a major design objective in the evaluation of any of the projects. Establishment of the various diversion control flow rates on the Connecticut and Millers River are one method of insuring an equitable distribution of the resource. Cost sharing rational developed for the projects for example includes provisions that the user pays the cost of the water.

Investigations conducted however did not reveal any widespread impacts to communities located downstream of the diversion intakes. Without such impacts it is difficult to argue that downstream entities are being injured and therefore entitled to compensation.

Comment: The impact statement should state explicitly the projections of demand for water and the assumptions which underlie these projects.

Response: Requested information will be found in the Introduction Section.

Comment: There should be an evenhanded and complete statement of the costs of all alternative approaches.

Response: Costs for the alternatives have been included.

Comment: The model for the economic analysis of interbasin transfers should be that included in the Draft Report of the National Water Commission.

Response: The five criteria included in the National Water Commission Draft Report for economic analysis of interbasin transfers were examined. On every count it is felt that the diversion projects under consideration meet these criteria.

With regard to the review recommendation, the projects under consideration would be subject to review by the mechanism in effect at the time of their submittal.

Comment: The preliminary draft isolates each alternative and considers it in isolation against the diversion project then discards it. The alternative of combining measures should be assessed.

Response: As required by the National Environmental Policy Act, viable alternatives to the proposed action which may lessen environmental impact must be reported upon. Alternative is by definition "an opportunity for choice between two things, courses or propositions, either of which may be chosen, but not both."

Comment: There is a notable lack of any explicit mention of land disposal of municipal sewage.

Response: In a highly urbanized area, such as eastern Massachusetts, it is difficult to find areas large enough to be suitable for land disposal of municipal sewage, considering the large quantities involved. In addition, public health authorities have expressed concern with such operations. Studies regarding use of land disposal for municipal sewage including availability of land, possible health problems, environmental and socio-economic impacts are presently being conducted by the Corps of Engineers under a separate NEWS study on wastewater management. The conclusions and recommendations for these wastewater management studies will be completed in the fall of 1974.

Comment: The socio-economic impacts are superficial, completely non-professional, biased and totally unconvincing. A neutral consultant should have been retained for the assessment of socio-economic impacts.

Response: The socio-economic impacts were performed by an independent neutral consultant under contract.

Comment: Construction impacts should be assessed.

Response: See Section 3, B7.

Comment: The statement in several places refers to "other alternatives outside the scope of the present project". It is difficult to understand the statement unless the scope of the project is, in error, defined narrowly to include only structural interbasin transfer alternatives.

Response: In the conduct of the study several contracts were let to consulting firms on portions of the investigation. The statement noted was made in one of these consultant reports and is valid with respect to his scope of services. However, the entire study considered all alternatives. The statement noted has been modified to reflect the entire study effort.

Connecticut River Ecology Action Corporation

Comment: See Massachusetts Audubon Society's responses.

Millers River Watershed Council Inc.

Comment: Can only deduce that the only concerns felt by the Corps of Engineer's study are for the possible receiver area. The fact that the transfer of water from the doner area to the receiver area could cause the same and additional problems to the donor area seems to have escaped the Corps attention.

Response: Socio-economic impacts of the diversions are described in the statement for both the supplier and receiver areas.

Comment: The Millers River only plan (Alternative No. 1) is the plan supported by the Council after clean up of the Millers River. The gaging station for such diversions should be established on the Millers River itself rather than on the Connecticut River.

Response: As described in the impact statement diversions from any of the Millers River Basin alternatives would be subject to two control flows. One of these is on the Connecticut while the second would be in the Millers River basin.

Comment: The preliminary draft environmental impact statement has lost sight of the "gut issue" in the environmental guidelines for the civil works program of the Corps of Engineers.

Response: Guidelines cited were used in the preparation of the statement.

Laura M. Stickel, E.Q. Chairman
League of Women Voters of Holyoke Area

Comment: No references are given for background data reports.

Response: References have been added to statement.

Comment: Population growth figures are outdated and too great.

Response: A comparison of population estimates used in the NEWS report and estimates recently prepared by the Commonwealth of Massachusetts do not reveal any major differences for the eastern Massachusetts region. Total population estimates for Worcester, Essex, Middlesex, Suffolk, Norfolk, Plymouth and Bristol counties used in the NEWS report differ by only 1% for 1990 from the state figures.

Comment: Communities in the "water rich"(referring to western Massachusetts?) region are restricted in their water use to a larger extent than those municipalities in the metropolitan regions.

Response: A review of communities which restricted water usage in 1966 reveals that a total of 103 Massachusetts municipalities curtailed supply to consumers to some degree. Of this total 76 communities were located in the central and eastern Massachusetts counties of Worcester, Essex, Middlesex, Suffolk, Norfolk, Bristal and Plymouth.

Comment: What will be the environmental impact of rock excavation and spoil areas.

Response: This item is addressed in Section 3, B7 of this statement.

Comment: The historical potential of diversion from the Millers River is not a valid reason for carrying out this plan today.

Response: The statement referred to was given as background information. No changes made.

Comment: Communities downstream from the diversion intakes rely upon ground water supplies. Diversion will have an adverse effect on the annual recharge of these wells and a potentially disastrous effect on these communities.

Response: See comment by David W. Stickel regarding ground water and response.

Comment: The value of fish other than those species important to anglers is not considered.

Response: See General Responses - **Biota and Non-Sport Fish in The Connecticut** River.

Comment: It is impossible to accept the statement "no changes are predicted for vegetative" given some areas probably will receive shorter periods of inundation. The vegetative cover is highly dependent on not only average amounts of water but on duration and season of water availability.

Response: The statement still stands. The amount of "change" in water levels and duration of flooding simply does not have the magnitude necessary to promote changes in species composition. The writer realizes the importance of water levels but also must take into account the characteristics of successful riverine plants, which, in order to be successful must be very adaptable to the changes in the river system such as temperatures and varying water levels.

Comment: I predict seasonal inundation will create a mudflat bare of vegetation promoting erosion and siltation.

Response: Represents a prediction by the reviewer. No back-up is given so we cannot respond to the reviewer's rationale.

Comment: What will happen to the water quality of the donor areas should diversion occur.

Response: Section 3, Environmental Impacts of Proposed Diversions discussion of impacts on water quality has been expanded.

Comment: The no diversion alternative is, on the contrary the most realistic.

Response: This represents an opinion by the reviewer.

Comment: The MDC at present must add any community to its system which chooses to join, provides the piping and guaranties purchase of an agreed volume annually. This creates a poor attitude toward water. Because the communities must purchase a guaranteed volume the local water resources are abandoned.

Response: Under present Massachusetts State legislation, the MDC system is required to permit any municipality within 10 miles of the State House in Boston to become a member upon application. The MDC is further bound by the same legislation to allow any other municipality within 15 miles of the State House which could be reasonably serviced by the MDC to become upon application a member. Any non-member municipality with the approval of the Massachusetts Department of Public Health can be furnished water by the MDC.

No new member outside the 10 mile limit can be admitted without a pubiic hearing and unless the Commission can show financial advantage to the District as a whole.

Although historically communities which joined the MDC turned over their local supplies for administration by the MDC in recent decades, the practice has not been followed. For example, sinec 1949 12 communities have been connected to the MDC system and retained their existing sources.

Comment: "Water rich" communities pay more for water than "water poor" areas.

Response: Costs of water charged by communities varies considerably depending on a number of variables. Included in these variables are age of system, water treatment required, number and density of service connections, pumping requirements and other engineering considerations. Comparison of prices between municipalities is not complete unless a full accounting is made of the variables (or reasons) which provide the basis for water costs.

For example retail water prices in communities serviced by the MDC vary from 27¢ to 67¢ per 1,000 gallons.

Comment: Summary sheet eliminates a number of alternatives on the basis of "cost". Diverted water is cheaper only because it is taken without dollar payment.

Response: All of the alternatives examined were evaluated on the basis of environmental, socio-economic and economic "costs" not simply on a dollar by dollar cost comparison.

Comment: Local resources should be utilized. Desalination and wastewater reuse programs must be examined for implementation.

Response: All of the items stated were evaluated for their potential in meeting future needs in the Survey Report. Additional data is also included in this statement.

Comment: Sanitary sewers must be separated from "storm sewers" in future building programs.

Response: At present building codes require new construction to separate storm and waste discharges.

Comment: Building codes must be changed to encourage water saving models for toilets.

Response: In Section 5 - Alternatives to the Proposed Action - a description of water saving appliances' possible advantages and disadvantages has been included.

Comment: Population zoning and regulations are needed to preserve the environment.

Response: This item was included in the Preliminary Draft Environmental Impact Statement - no changes made.

League of Women Voters of Massachusetts

Comment: What we question is the somewhat unbalanced values assigned to donor and receiver issues - is the loss of a lawn any more traumatic to an MDC user than the loss of a trout stream to a Tarbell Brook resident? Fish and grass are desirable though not necessarily equal elements of man's environment.

Response: The evaluation process in any project is a complex problem. In the subject project citizen input to aid in the evaluation process was sought through public progress and informational meetings. The findings included in the project report reflect information gathered at these meetings.

Comment: NEPA requires exploration of all possible alternatives to a proposed project including the alternative of no project. We feel that some of the alternatives are rejected without benefit of the depth of analysis and research given to the proposed diversions.

Response: The section on alternatives to the proposed action has been expanded.

Comment: Re water demand control figures on water use within the MDC and the manner in which this water is used must be developed before the alternative of demand control is negated.

Response: The investigation of the potential which water demand control techniques may have in meeting future needs is recommended as a concurrent action to project implementation.

Comment: Re pricing restraints, is the Siedel and Baumann assessment of the minor effect of rate adjustment relevant to MDC?

Response: The assessment attributed to Siedel and Baumann is included together with other investigators analyses on pricing impacts to give the reader the range of opinion which exists on the subject.

Comment: A number of comments interspersed throughout the League of Women Voters letter refer to the need for a better knowledge and use of how and where water is used in the communities which would be served by the project.

Response: As one of the project report's recommendations, a survey of available water usage and means to insure wise use and conservation of this supply was recommended. This investigation would proceed concurrently with further investigations of the project itself.

Lake Cochituate Watershed Association, Inc.

Comment: The benefits of water demand control should be discussed in greater detail.

Response: The entire section on alternatives has been expanded including the above referenced section.

Save Our Streams

Comment: The solutions or alternatives that the Corps has proposed are not long range solutions to the water supply-demand problem.

Response: Represents statement of the opinions of the reviewer. Not answerable as a comment.

Comment: This preliminary draft Environmental Statement is not an honest assessment of the impact the proposed diversion out of its natural watershed will have on the two watersheds.

Response: Major portions of the study effort were conducted by independent contractors who are specialists in their particular field. For example, the Essex Marine Laboratory of Essex, Connecticut carried out the research which indicated that no change is anticipated in salinity levels in the estuary during diversion periods. The point being that the Corps of Engineers went to "outside" experts to provide the necessary scientific imput to the planning process.

Comment: Because the potential of the Millers River Basin as a water supply was recognized in the 1920's does not necessarily mean that the solution is a competent one, on the sole answer to the water supply problem.

Response: Agree, statement was included to describe the history of water supply planning in the region.

Comment: The statement that the socio-economic impact on the donor area is to be positive is highly questionable and a direct contradiction of the fact that there can be no guarantee made on the quality of the water at the time of diversion in the basin itself or in Quabbin Reservoir.

Response: The installation of advanced waste treatment facilities on point sources of pollution in the Millers River as part of the water supply project cannot help but have a positive effect on water quality and associated socio-economic activities.

Comment: It is a well-known fact that labor forces for the project would consist of out-of-town help.

Response: It was assumed that union labor would be employed on the projects and that some members of the affected communities belong to trade unions.

Comment: If large socio-economic impacts are to be felt by towns supplied by the Quabbin-Sudbury System in a"no-go" situation, the fault lies solely in the hands of the Metropolitan District Commission for their failure to urge conservation.

Response: The Massachusetts' legislative charge to the MDC is to supply water to member communities not to mandate the amounts and use of water.

Comment: Referring to page 150 and the section on the "imposing of Restrictions on Water Use" the reviewer feels the consumer is willing to curtail his consumption of water.

Response: Represents an opinion of the reviewer.

Comment: Page 26 refers in depth to the Priest Brook alternative. This has been repeatedly denied as an alternative by the Corps, yet it still, in fact, a viable consideration.

Response: The Priest Brook alternative was included in the statement as required by NEPA. In the project report, this alternative as well as the Millers River alone alternatives are not selected as the recommended course of action. In order to prevent further confusion to the reader the statement has been restructured to delineate clearly the preferred alternative.

Comment: Silting is obvious on Royalston Road north from a recent construction project on the Priest Brook. Yet the Corps concludes that silting is minimal. This area has a fine sand content and the lack of current survey on silting again casts doubts on the credibility of this statement.

Response: The construction project referred to by the reader is unknown to the Corps of Engineers. It may be that poor construction techniques were employed by whoever was involved. Long term records on silting within Corps reservoirs available to the New England Division, however do not reveal silting as a problem in the area.

Comment: The East Branch Tully River again is a classic example of the lack of consideration given to the natural environment by the Corps of Engineers. The eight miles of wetland definitely bound to be affected by a loss of water necessary to the riverine cycle.

Response: Because of interest expressed by many reviewers regarding wetlands, information on this subject has been expanded.

Comment: Short term solutions is amplified for the period 1989-2000 on pages 59 and 60. The statement "we envision probable changes",... shows the type of guesswork encompassed in this statement. Page 63 has a chart which diagrams the eight year period that Millers can completely handle the demand. $38 million for an eight year solution is foolish.

Response: The evaluation of environmental impacts in many cases is in its infancy. In some cases the state of the art only allows the use of professional judgement in making predictions hence use of such terms as "probable" etc. is required. The reference to 38 million for an eight year solution may be due to a misunderstanding on the part of the reviewer. The project of course would contribute to water supply needs well beyond 1990 although by itself it could not provide all the water needed.

Comment: How is it that no odor was detected at Millers River? (P. 76)

Response: Statement refers to stations on northern tributaries of the Millers River, not the main stem of the stream.

Comment: What data backs up low significance of impacts on page 79?

Response: References have been added to this revised draft Environmental Impact Statement.

Comment: On page 83, the construction phase of diversion is a definite ingredient on environmental impact. The validity of an impact statement of not including it is questionable.

Response: Requested information is found in Section III, B7 of this statement.

Comment: No guarantee diversion below the presently postulated limits.

Response: The diversion rates tested as described in the statement are far in excess of those proposed in the considered projects. Diversion rates below these tested values such as those in the proposed action would cause even less effect.

Comment: Chloride table dated 1935-1937 is insidious by its inclusion.

Response: The 1935-1937 study of the salt content of the Connecticut River was the most comprehensive undertaken up to the present time . Scientists of the Essex Marine Laboratory, Essex, Connecticut who conducted our Lower Connecticut River studies were convinced that Meade's information on salinity represented the salt condition of the river today.

Comment: There is no basis for the astounding, ridiculous statement that there will be no appreciable impact on the Millers River Watershed.

Response: Reviewers apparently misread the statement as it reads "that there will be no appreciable impact on the hydrology of the Millers River Watershed, although a greater effect will be noticeable on the Millers River mainstem since a larger percentage of water will be diverted during the diversion period.

Comment: Current high record rainfall has continued into 1973. This should be included.

Response: It is discussed.

Comment: Show that people are willing to conserve, per the National Wildlife Federation Survey (1972).

Response: Impacts described are based on the reactions of "case study" community which has suffered water shortages recently.

C. Russell Shaw

Comment: Disturbed by easy acceptance of public disapproval of water use restrictions. It seems essential that public education on water conservation should proceed rapidly.

Response: The alternative of public education and conservation programs has been added to the impact statement. Although it is concluded such programs are not in and of themselves alternatives to the proposed projects such education programs are included in the study report's recommendations.

Jean A. Simoneau

Comment: With regard to the description of the Priest Brook Diversion, there is also a tree farm containing more acreage than the combined holdings of the trailer park and rod and gun clubs.

Response: Reference to a tree farm in the project area has been added.

Comment: In Section 7 - Irretrievable or Irreversible Commitment of Resources reference to "Structure can be removed and the land restored to its former condition" is fallacious and misleading.

Response: This section has been revised with the above mentioned reference deleted.

Comment: The statement "nearly all reparian rights along the reaches of Tarbell and Priest Brooks affected by the proposed diversion are controlled by the Corps of Engineers Birch Hill Dam" does not portray accurately land ownership in the project areas.

Response: The statement referred to is in a paragraph describing the effect of reduction in stage in the stream reaches downstream of the diversion intakes. No reference to land ownership is made or intended.

Comment: The impact statements' assessment that the Priest Brook project will not affect endangered species or bird habitat is hard to believe.

Response: Reviewer miscontrued the term endangered species. This refers to a list of such species kept by the U.S. Bureau of Sport Fisheries and Wildlife. This list is reviewed by the Corps of Engineers to insure that no endangered species would be affected by the project and a statement to that effect is included in each project environmental impact statement.

Comment: Socio-economic impacts as described in the impact statement are not based on hard data.

Response: The measurement of socio-economic impacts is far from an exact science. However, in assessing such impacts the services of a consulting firm with experience in such impact analysis was utilized.

Warren M. Sinclair

Comment: Description of waste treatment plants required on point sources of pollution should read "advanced waste treatment plants".

Response: Correction as suggested has been made to text.

Comment: The exact position of flow monitoring stations should be spelled out.

Response: The exact location of flow monitoring stations would be a subject included in the advanced engineering and design phase. However, the various alternative descriptions regarding such flow monitoring stations has been altered to point out that such stations would be located both upstream and downstream on the river in which an intake is located. For example, gaging stations would be located upstream and downstream in the Millers River itself for any plan involving the Millers River.

Comment: Is the 17,000 cfs control flow used for the Connecticut River appropriate.

Response: See General Response - Connecticut River Control Flow.

Comment: There appears to be a conflict in degree of flood protection from Alternative No. 2. One sentence reads "also provides flood control protection " while another reads "protection is minimal."

Response: Sentences in the statement regarding possible flood control protection have been revised to note the minor additional benefits from this plan.

Comment: The statement includes the sentence "Some 30 miles of streams would become excellent quality". The location of this sentence leads the reader to believe tributary water quality would be improved where they are excellent quality present.

Response: Sentence referenced has been moved to impacts on the Millers River portion of the discussion.

Comment: Sentence which reads "... it must be borne in mind that Alternate No. 1 or No. 2 would not be implemented until water quality of the Millers River meets all public health as well as environmental standards present at Quabbin" would infer that the difference between the two plans is 8 mgd.

Response: The sentence reference should have read "... it must be borne in mind that the Millers River portion of Alternate No. 1 or No. 2 would ...".

Comment: Stage development of the Millers River project using Alternative No. 1 as the recommended project with the Tully portion of Alternative No. 2 as a back up appears to be a reasonable approach.

Response: Because of uncertainties regarding use of the Millers River when needed, Alternative No. 2 (with the Tully River) was chosen as the preferred project. If authorized the project would move to the advanced engineering and design phase. During this phase the suitability of the Millers River water quality based on tests performed at that time would be reexamined. If the rivers' quality were found suitable for diversion at that time, the risk of using the Millers River alone would no longer be an element in the project selected for construction. In other words the design and construction sequence provides considerable flexibility in choosing the project actually constructed.

David W. Stickel, Assistant Professor of Biology, Holyoke Community College

Comment: Abbreviations are used for which no definitions are given.

Response: A glossary has been added to the statement.

Comment: No references are given for background data reports.

Response: References have been added to statement.

Comment: Typing errors noted.

Response: Corrected in statement.

Comment: Costs of groundwater development should be included.

Response: Cost data is now given in the statement.

Comment: Questions adoption of 17,000 cfs at Montague City control flow and the environmental baseline this flow rate signifies.

Response: This item is addressed in General Responses - Connecticut River Control Flow.

Comment: Concrete information that diversions will not have a detrimental effect on the donor and recipient area is lacking.

Response: The information contained in the impact statement is not tended to insure that project impacts are not detrimental! Rather the intent is to define areas of environmental concern such that they may be assessed in the project evaluation.

Comment: Statement lacks sound data on the effect of diversion on basin groundwater supplies.

Response: The United States Geological Survey (USGS) were asked for their expert opinion on whether diversions as proposed would affect groundwater supplies. The USGS replied that in their opinion no significant impact would occur with the proposed diversions.

In the comment stated, reference is made to a paper[1] presented at the 1971 New England Conference on River Diversions and a quote from the referenced paper is included. An examination of the technical report from which the conference paper was drawn, however, reveals the conclusion that diversions 4 times those discussed in the impact statement "would not decrease the river's recharge capability to any noticeable extent."

Comment: Information is lacking as to the environmental impact of construction and annual cleanup of spoils.

Response: This item is addressed in Section 3B 7.

Comment: Costs of desalted water are given for present technology not for future potential and desalination is best solution.

Response: This item is addressed in General Responses-Desalination.

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[1] Role of Connecticut River Flood Flows in Recharging Groundwater Formations by Oswald C. Farquhar.

New England Chapter Sierra Club,
Connecticut River Basin Task Force

Comment: Diversification with development of alternative sources of supply should be undertaken for several reasons. Surface water sources is particularly susceptible to pollution. A statement prepared by Western Mass. Electric Co. indicates Connecticut River water contains phenols, copper, lead and zinc which may impede use of this source for water supply. It should also be noted that Millers River water will at times be drawn upstream by pumping the water through the Northfield Mountain pumped storage intake.

Response: At present a number of surface water sources are used to furnish supply to the Quabbin-Wachusett-Sudbury Reservoir system. In the Connecticut River basin, the Swift River with its highly protected watershed furnishes water to Quabbin. In addition a separate river, the Ware under adopted sanitary regulations is diverted to Quabbin during high flow periods. The Wachusett and Sudbury Reservoir systems are each supplied water by separate tributaries of the Merrimack River Basin. In addition to the existing diversification of sources now used for supply purposes in the main reservoir system, there also exists within a number of the serviced municipalities independent supplementary sources both surface and ground. This existing configuration of available sources offers a degree of flexibility and protection to consumers.

Water quality investigations of the Connecticut River were conducted as part of the NEWS report. On the basis of those investigations, water quality in the Connecticut River was found to be suitable for use after storage in Quabbin. It is anticipated that existing river water quality will be significantly improved following planned pollution control measures. In order to insure continuing high quality water within the system, a monitoring program is included in the reports recommendation section.

The reference to Millers River water being drawn into the Northfield Mountain intake refers to a low flow condition. The contemplated diversion would occur during high flow periods.

Comment: Changing economics resulting from improved technology and periodic reassessment of priorities should be factors in weighing alternatives. For example, desalination in the future may provie economical.

Response: The statement's analysis of alternatives to the proposed action is based on present state of the art. Prior to actual construction of the project the then state of the art of alternatives together with priorities would be reevaluated.

Comment: Flood waters are necessary to the salt: fresh water balance in the estuary. The success of the anadromous fish restoration program depends on the excess flow of fresh water in the Connecticut River in late spring time.

Response: These items are considered and described in 3A-1 and 3B-1.

Comment: The importance of developing ground water supplies have been badly under emphasized.

Response: The section on the ground water alternative has been expanded.

Comment: The use of Quabbin waters for flushing purposes should be re-examined for the Chicopee and Charles River.

Response: To our knowledge Quabbin water is not used for flushing the Chicopee and Charles River. Water released from Quabbin is in accord with a U.S. Supreme Court ruling. Re regulation of Quabbin Reservoir releases were investigated and are described in Alternatives to the Proposed Action.

Comment: A reorganization of priorities within the MDC is urged. The South Sudbury and Cochituate Reservoirs and the Sudbury River should be cleaned up and used in the system.

Response: The potential of utilizing portions of the Sudbury system is under investigation by the MDC.

Comment: Finally, the concept that what is good for Boston is good for the Commonwealth should be reconsidered.

Response: Represents an opinion of the reviewer.

## GLOSSARY OF ECOLOGICAL TERMS

Below is a list of ecological terms which are used frequently by personnel of the Environmental Resources Section when writing Environmental Impact Statements and other correspondence.

Terms underscored in a definition are separately defined in this Glossary. Where appropriate, closely associated or related terms are cited parenthetically, (See. ---), following the definition.

ACCLIMATION- Physiological and behavioral adjustments of an organism in response to a change in environment. (See Adaptation).

ADAPTATION- Change in structure, form or habits of an organism to better fit changed or existing environmental conditions. (See Acclimation).

AEROBIC- Refers to life or processes occurring only in the presence of free oxygen. (See Anaerobic)

ALGAE The simplest of all plant forms having neither roots, stems, nor leaves. Algae forms the base of the food chain in aquatic environments. Some species may create a nuisance to other life forms when environmental conditions are suitable for prolific growth.

ANADROMOUS- (A-NĂ-DRO-MOUS) Pertains to those fish that spend most of their life in salt water but enter freshwater to spawn; e.g. salmon, shad, striped bass, etc. (See Catadromous)

ANAEROBIC- Refers to life or processes occurring in the absence of free oxygen. (See Aerobic)

APHOTIC ZONE-An area within the water column in which light does not penetrate with sufficient intensity to maintain photosynthesis. (See Euphotic Zone).

AUTOTROPHIC- (AU-TO-TRO-PHIC) Self nourishing; denoting those organisms that do not require an external source of organic material but can utilize light energy and manufacture their own food from inorganic materials; e.g. green plants. (See Heterotrophic)

BENTHOS- Collective term for organisms attached or resting on the bottom or living in the bottom sediments of oceans or lakes; e.g. oysters, clams, worms, attached algae, flounders. (See Nekton, Demersal, Pelagic).

BIOMASS- The total amount of living material in a particular habitat or area; or, an expression dealing with the total weight of a given population of organisms.

BIOTA- All life of a region.

BOD(biochemical oxygen demand) A measurement of the amount of oxygen required by aerobic (oxygen demanding) organisms (usually bacteria ) in the decomposition or break-down of organic matter. (See COD)

BRACKISH WATERS- Those areas where there is a mixture of fresh and salt water.

CARNIVORE- Pertains to an animal that feeds on other animals. (See Herbivore, Omnivore)

CATADROMOUS- (CA-TĀ-DRO-MOUS) Pertaining to fish that spend most of their life in freshwater, but migrate to the sea to spawn; e.g. American eel. (See Anadromous).

COD(chemical oxygen demand) - Measurement of the oxygen equivalent of that portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant. (See BOD)

COMMUNITY- An assemblage of populations living in a prescribed area or physical habitat; all the populations occupying a given area; the living portion of the ecosystem.

COPEPODS- (CŌ-PE-PODS) A group of minute aquatic organisms (about 0.1 inches long) that have rounded bodies and a pair of elongated oarlike swimming appendages; found everywhere in shallow waters and part of the open-water plankton of ponds, lakes and oceans. (See attached figure)

DEMERSAL- (DE-MĒR-SAL) Pertains to those aquatic organisms that live near the bottom of a body of water. (See Benthos, Pelagic, Nekton)

DETRITUS- (DE-TRĪ-TUS) The mass of non-living matter composed of dead organisms (and their fragments) and the inorganic constituents such as clay particles and sand grains.

DIATOM- (DĪ-A-TOM) A single-celled algae encased in an intricately etched pair of silica shells that fit together like a box and its lid; they occur abundantly as floating forms in plankton. (See attached figure)

DIURNAL - 1. Refers to an event, process, or specific change that occurs every day, usually associated with changes from day to night.

2. Pertaining to those organisms that are active during day time.

ECOLOGY- The study of the relation of organisms or groups of organisms to their environment; the science of the inter-relations between living organisms and their environment; study of the structure and function of nature; the science of the living environment; environmental biology.

ECOSYSTEM- A unit in which the community and the non-living environment function together.

EMBRYO- (ĔM-BRY-O) An early developmental stage of an organism produced from a fertilized egg.

EPILIMNION- In a thermally stratified lake, the uppermost layer which extends from the surface to the thermocline; (See attached map, also Thermocline, Hypolimnion)

ESTUARY- That portion of a coastal stream influenced by the tide of the body of water into which it flows; a bay, at the mouth of a river, where the tide meets the river current; an area where fresh and marine waters mix. (See Brackish)

EUPHOTIC ZONE- The lighted region of a body of water that extends vertically from the water surface to the depth of effective light penetration. (See Aphotic Zone)

EURY- Prefix denoting a wide range of tolerance of an organism to a specific environmental factor; e.g. euryhaline refers to salinity; eurythermal refers to temperature. (See Steno)

EUTROPHIC- Term generally applied to a shallow, highly productive body of water which possesses an extensive littoral zone with plant growth and is rich in the basic nutrients. (See Oligotrophic)

EUTROPHICATION- The natural process of the maturing (aging) of a lake; the process of enrichment with basic nutrients leading to increased production of organic matter.

FOOD CHAIN- The transfer of food energy from the source in plants through a series of organisms with repeated eating and being eaten.

GENUS- A rank category in the Taxonomic classification for a group of very closely related species. (Ex: the white perch, *Morone americana*, and the striped bass, *Morone saxatiles*, are very closely related species and have therefore been placed into the genus *Morone*). (See Species)

HABITAT- The specific type of place or location where an organism lives. (See Niche)

HERBIVORE- An organism that feeds on plant material. (See Carnivore, Omnivore)

HETEROTROPH- (HĒ-TER-O-TROPH) An organism which must obtain both inorganic and organic raw materials from the environment for survival. (See Autotroph)

HYPOLIMNION- In a thermally stratified lake the zone which extends from the thermocline to the bottom; usually devoid of oxygen and high in carbon dioxide. (See Epilimnion, Thermocline and attached map)

INVERTEBRATES- Animals without an internal skeletal structure (without a backbone); e.g. insects, clams, lobsters. (See Vertebrate)

LITTORAL- (LĪT-TO-RAL) A relatively shallow area within a body of water which extends from the shore to the edge of a deep hole (freshwater) or the edge of the continental shelf (oceanic waters).

NANNOPLANKTON- Very minute plankton not retained in a plankton net equipped with No. 25 silk bolting cloth, (mesh, 0.03 to 0.04 mm).

NATALITY- The rate at which new individuals are produced; the birth rate.

NEKTON- Collective term for the actively swimming organisms in oceans and lakes. (See Benthos, Pelagic, Demersal)

NICHE- An organism's way of life; its "occupation."

NUTRIENTS- Elements, or compounds essential as raw materials for organism growth and development; e.g. carbon, oxygen, nitrogen, phosphorous, etc.

OLIGOTROPHIC- Term generally applied to a relatively deep body of water which lacks an extensive littoral zone and is poor in dissolved nutrients; plankton is usually scarce and productivity is low. (See Eutrophic)

OMNIVORE- An animal which may subsist on plant foods, animal foods, or both. (See Herbivore, Carnivore)

PARASITE- An organism living on or within a host organism, more or less detrimental to the host. (See Symbiosis)

PELAGIC- Habitat zone comprising the open waters of a basin. (See Nekton, Benthos, Demersal)

PHYTOPLANKTON- Collective term for the plants of the plankton. Unattached microscopic plants subject to movement by wave or current action. (See Zooplankton)

PHOTOSYNTHESIS-A biochemical process by which organisms manufacture sugar or other carbohydrates from inorganic raw materials with the aid of light and pigments such as chlorophyll.

$$CO_2 + H_2O + \begin{matrix}\text{Energy}\\ \text{from}\\ \text{Sunlight}\end{matrix} \xrightarrow{\text{chlorophyll}} \underset{\begin{matrix}\text{carbohydrate}\\ \text{unit}\end{matrix}}{CH_2O} + O_2 \text{(by product)}$$

PLANKTON- Collective term for passively floating or drifting plants (phytoplankton) and animals (zooplankton) in a body of water; consists largely of microscopic organisms.

POLLUTION(water) Those man-induced changes in the water which are damaging to the uses which other men make or might make of those waters, and of their products. Any impairment of water quality that adversely and unreasonably affects the subsequent beneficial uses of such water.

POPULATION- A collective group or organisms of the same species occupying a particular area.

PRODUCTIVITY- The rate at which energy is stored by producer organisms (chiefly green plants) in the form of organic matter which can be used as food material .

PROLIFIC- Pertaining to organisms that have a high reproduction rate and normally produce large numbers of young.

RESPIRATION- The complex series of chemical and physical reactions in all living organisms by which the energy and nutrients in food is made available for use. Oxygen is used and carbon dioxide released during this process.

SERE- Any given stage in the ecological succession of communities.

SESSILE- (SÉS-SILE) Pertaining to those organisms that are permanently attached to a surface and are not free to move about.

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|---|---|
| SPECIES- | A category of taxonomic classification below genus rank defined as an organism or organisms forming a natural population, or groups of populations, that transmit specific characteristics from parent to offspring. (e.g. the white perch, Morone, americana. Each species is reproductively isolated from other species with which they might breed. Hybrids, the results of interbreeding, usually exhibit a loss of fertility. |
| STENO- | Prefix denoting a narrow range of tolerance of an organism to a specific environmental factor; e.g. stenohaline refers to salinity; stenothermol refers to temperature. (See Eury) |
| SUCCESSION - (ecological) | The orderly process of community change; the sequence of communities which replace one another in a given area. |
| SYMBIOSIS- (SYM-BI-Ó-SIS) | The intimate living together of two organisms of different species for mutual or one-sided benefit. (See parasite) |
| TAXONOMY- | Classification of organisms with reference to their relationship (resemblances and differences) in the plant and animal kingdom. |
| THERMOCLINE- | The transition zone between the warm epilimnion and cold hypolimnion of stratified bodies of water; zone of rapid drop of temperature with depth; temperature equals or exceeds 1°C (1.8°F) for each meter (39.37 inches) of depth. |
| VERTEBRATE- | Animals that have an internal skeletal system (with a backbone); e.g. fish, man. (See Invertebrate) |
| ZOOPLANKTON- | The animals of the plankton; unattached microscopic animals that have minimal capability for locomotion. (See Phytoplankton). |

List compiled by Robert J. Leger-Environmental Resources Section

# APPENDIX A

# COMMENTS RECEIVED

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

Mansfield Professional Park, Storrs, Connecticut 06268

December 15, 1972

Mr. John Wm. Leslie
Chief, Engineering Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

We have reviewed the Preliminary Draft Environmental Statement for: The Northfield Mountain and Millers River Basin Diversion proposals of the Northeast Water Supply Study.

The effects of the proposal as set forth in this statement are outside our area of responsibilities; therefore, we have no comments.

Sincerely,

Robert L. Hilliard

Robert L. Hilliard
State Conservationist

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
29 Cottage Street, Amherst, Massachusetts 01002

December 18, 1972

Mr. John Wm. Leslie, Chief
Engineering Division
New England Division, Corps of Engineers
Department of the Army
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

We have reviewed the Preliminary Draft Environmental Statement (November 1972) for the Northfield Mountain Water Supply Project, Miller's River Basin Water Supply Project of the NEWS Study with regard to the environmental aspects related to our areas of expertise. I have consulted with the State Conservationists in Vermont and New Hampshire and we have no comment to offer on this statement.

We appreciate the opportunity to review and comment on this proposed project.

Sincerely,

Benj. Isgur

Dr. Benjamin Isgur
State Conservationist

cc: K. Grant
D. Burbank (N.H.)
C. Right (Vt.)
T. C. Byerly

21 DEC 1972

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

Federal Building, Durham, New Hampshire 03824

November 29, 1972

Mr. John Leslie
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear John:

We are referring the Preliminary Draft and Environmental Statement for the Northfield Mountain Water Supply Project and the Miller's River Basin Water Supply Project to Dr. Benjamin Isgur, State Conservationist, Soil Conservation Service, Amherst, Massachusetts, for review and comment.

His response to you will represent the Soil Conservation Service's views on this project.

Sincerely,

D. G. Burbank

Donald G. Burbank
State Conservationist

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
337 Cowesett Avenue, West Warwick, Rhode Island 02893

November 21, 1972

Mr. John Wm. Leslie, Chief
Engineering Division
Department of the Army
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

The Soil Conservation Service in Rhode Island has reviewed the Preliminary Draft Environmental Statement for: The Northfield Mountain and Millers River Basin Diversion proposals of the Northeast Water Supply Study.

The physical effects of this proposal do not touch on any of our areas of responsibility. Therefore, we have no comment.

Sincerely yours,

Austin L. Patrick, Jr.

Austin L. Patrick, Jr.
State Conservationist

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UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, 96 College St., Burlington, Vermont 05401

December 1, 1972

Mr. John Leslie
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Mr. Leslie:

In regard to the review of the Preliminary Draft and Environmental Statement for the Northfield Mountain Water Supply Project and the Miller's River Basin Water Supply Project, Dr. Benjamin Isgur, State Conservationist, Soil Conservation Service, Amherst, Massachusetts, will respond for the Soil Conservation Service as per your request.

Sincerely,

Craig M. Right

Craig M. Right
State Conservationist

cc: Dr. Isgur
R. Davis
D. Burbank
H. Hilner

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
AREA OFFICE
BULLFINCH BUILDING, 15 NEW CHARDON STREET
BOSTON, MASSACHUSETTS 02114

REGION I
REGIONAL OFFICE
BOSTON, MASSACHUSETTS

AREA OFFICES
Boston, Massachusetts
Hartford, Connecticut
Manchester, New Hampshire

January 24, 1973

IN REPLY REFER TO:

Mr. John WM. Leslie
Chief, Engineering Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

Subject: New England Division, Corps of Engineers
Preliminary Draft Environmental Statement
Northfield Mountain Water Supply Project
Miller's River Basin Water Supply Request

We have evaluated the preliminary draft environmental impact statement for the subject project. The project involves solutions for meeting future water supply requirements for Eastern Massachusetts and explores various alternative ways to meet the projected needs for this region. Proposals include diversion during high flow periods from the Connecticut River via the Northfield Mountain pumped storage facility directly to Quattin Reservoir and by three other alternative methods to utilize and transport water from the Millers River Basin to the Quattin Reservoir.

The review of the statement was made based on the areas of the Department of Housing and Urban Development's responsibility and expertise were taken from CEQ Guidelines, April 23, 1971, and include land use and management planning in urban areas with respect to Parks, Forests and Outdoor Recreation, Flood Plains and Watershed areas.

Our evaluation indicates that the statement as submitted is adequate and that it does not impact on HUD projects. The statement also appears to cover adequately the environmental aspects of the project.

We do recommend that the proposal be reviewed by the appropriate areawide planning agencies to determine consistency with Comprehensive Water Planning in those jurisdictional areas.

This agency has no additional comments with respect to the Preliminary Draft Environmental Impact Statement.

Sincerely,

David L. Myers
Assistant Director for
Planning and Relccation

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U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION ONE
990 Wethersfield Avenue
Hartford, Connecticut 06114

November 24, 1972

IN REPLY REFER TO: 01-06.3

NEDED-R
Preliminary Draft Environmental Statement for: The Northfield Mountain and Millers River Basin Diversion proposals - Northeast Water Supply Study

Mr. John Wm. Leslie
Chief, Engineering Division
Department of the Army
New England Division,
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

We have reviewed the subject Draft Environmental Statement and have determined that it has no adverse affect on the Federal-aid highway program within the State of Connecticut.

Sincerely yours,

Lew Harris

For: A. J. Siccardi
Division Engineer

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION ONE
612 J.F.K. FEDERAL BUILDING
BOSTON, MASSACHUSETTS 02203

IN REPLY REFER TO:

December 22, 1972

Mr. John Wm. Leslie, Chief
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Mr. Leslie:

Please be advised that we have no significant comments on the Draft Environmental Statement for the Northfield Mountain and Millers River Basin Diversion proposals of the Northeast Water Supply Study.

We appreciate the opportunity afforded to us to review the Draft Statement.

Very truly yours,

E. Elinsky

E. Elinsky
Acting Division Engineer

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION ONE
219 Federal Building
Concord, New Hampshire

IN REPLY REFER TO:

December 26, 1972

Mr. John W. Leslie
Chief, Engineering Division
New England Division
Corps of Engineers
Department of the Army
424 Trapelo Road
Waltham, Massachusetts

Dear Mr. Leslie:

Subject: Draft Environmental Impact Statement
Northfield Mountain and Millers River Basin
Water Supply Projects

We have reviewed the subject draft EIS, submitted by your November 13, 1972 letter, and it does not appear that your proposed projects will have any significant effect on our highway program in New Hampshire.

Thank you for the opportunity to comment.

Sincerely yours,

F. T. Comstock, Jr.

F. T. Comstock, Jr., P.E.
Division Engineer

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FEDERAL POWER COMMISSION

REGIONAL OFFICE
26 Federal Plaza
New York, New York 10007

December 21, 1972

Mr. John W. Leslie
Chief, Engineering Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

We have received your Preliminary Draft Environmental Statement for the Northfield Mountain and Millers River Basin Diversion proposals of the Northeast Water Supply (NEWS) Study.

Our principal concern with developments affecting land and water resources is the possible effect of these developments on bulk power facilities, including potential hydroelectric developments, and on natural gas pipeline facilities. The proposed Northfield Mountain diversion project would use a high flow skimming technique principally during the spring run-off period.

The diversion of 375 mgd, when Connecticut River flows are high, would not affect the power operations of the Northfield Mountain pumped storage project. It is anticipated that about 1100 acre-feet of additional storage in the upper reservoir would be provided as would the necessary head works and connecting aqueduct to Quabbin Reservoir.

We appreciate the opportunity to comment on this matter.

Sincerely,

John H. Spellman

John H. Spellman
Regional Engineer

OFFICE OF ECONOMIC
OPPORTUNITY

EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON, D.C. 20506

January 10, 1973

Mr. John Leslie
Chief, Engineering Division
Department of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Re: Draft Environmental Statement
Northfield Mountain and
Millers River Basin Division
Massachusetts

Dear Mr. Leslie:

Phillip Sanchez, the Director of the Office of Economic Opportunity, has asked me to respond to your letter regarding the draft environmental statement on the above mentioned project.

This office in coordination with our Regional Office and the affected community action agencies have carefully reviewed this statement. On the basis of information from this review, we have no reason to believe that the proposed action will have an adverse environmental impact on the low income neighborhoods involved. Should we receive any further information we will advise.

We appreciate the opportunity to comment on this draft statement.

Sincerely,

Arthur J. Reid, Jr.

Arthur J. Reid, Jr.
Director
Intergovernmental Relations

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The Commonwealth of Massachusetts
Metropolitan District Commission
20 Somerset Street, Boston 02108

December 28, 1972

Mr. John William Leslie
Chief, Engineering Division
Department of the Army
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

I have been requested by the American Water Works Association to submit any suggestions or recommendations regarding Preliminary Draft Environmental Statement for the Northfield Mountain and Millers River Basin Diversion proposals of the Northeast Water Supply Study, copy of which enclosed herewith.

I have taken the liberty of sending you a copy of my report.

Very truly yours,

Allan Grieve, Jr.
Director of Water Division and
Chief Water Supply Engineer.

AG/AM

Enc.

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The Commonwealth of Massachusetts
Metropolitan District Commission
20 Somerset Street, Boston 02108

December 28, 1972

Mr. Cliff Atkinson, Jr.
Secretary, Resources Division
American Water Works Association
704 National Press Building
Washington, D. C. 20004

Dear Mr. Atkinson:

In accordance with your request of December 7, 1972, I am submitting the following comments on the Preliminary Draft Environmental Statement for the Northfield Mountain and Millers River Basin Diversion proposals of the Northeastern Water Supply Study.

This is a very comprehensive report involving solutions for meeting future water supply requirements for Eastern Massachusetts and the possible environmental impacts. Cooperation of the various Federal, State and local agencies has been very good. Many public meetings have been held to furnish information and solicit comments on the various proposals.

The present water supply situation in Eastern Massachusetts is very critical. With sharply increasing water consumption, plus the request of additional communities to join the Boston Metropolitan Water District, it is becoming more difficult to fill Quabbin our main storage reservoir. The present year, 1972, has had above normal rainfall. However, it does not preclude the obvious and critical need to augment the existing system with additional sources. The total consumption from the Metropolitan District Commission water system has exceeded its safe yield for the last four years, which clearly indicates the serious need to immediately undertake a program to augment the supply.

The following is taken from the report of the Metropolitan District Commission relative to the diversion of excess water from Millers River and other sources into Quabbin Reservoir as requested by Chapter 66 of the Massachusetts Resolves of 1971.

"Failure to augment the existing supply system could turn the apparent advantage of the 1972 surplus into a condition wherein a water crisis of monumental proportion could occur beyond the next ten-year span which could impact adversely upon those communities which are presently served and those communities which must be served in the future by the Metropolitan Water System."

Additional sources of water are necessary for the Metropolitan District Commission to continue to supply its users with an adequate water supply. Further, these additional sources are needed in the very near future if a serious water shortage which would affect 40% of the population of Massachusetts is to be averted.

The amount of water that may be diverted at Northfield Mountain is limited by Massachusetts law for over a three consecutive year period to 375 million gallons per day for each day that the Connecticut River flow exceeds 17,000 c.f.s. at Montague City. Diversion is prohibited by law on any day when flow is less than 17,000 c.f.s. (Chapter 766 of the Acts of 1970).

The diversion of any flows above 17,000 c.f.s. at Montague City in Massachusetts would seem to be sound resource management.

Chapter 803 of the Acts of 1972 authorized and directed the Metropolitan District Commission to make studies of and prepare comprehensive plans and programs for the further development of its water supply system for the purpose of providing the cities and towns which are members of the Metropolitan Water District, the cities and towns which are eligible to become members of said district, and other municipalities of the Commonwealth which are obtaining, or in the future may obtain, all or a portion of their water supply from the facilities of the Commission.

The New England River Basins Commission recommends continued evaluation for adverse environmental effects throughout project planning, development and operation, with mitigation of environmental damage or repair by removal of the cause.

Transfer of excess flows from the Connecticut River Basin in considered an essential short term solution and is therefore not considered inconsistent with a long term strategy of satisfying resources needs through sound management of population and economic growth patterns.

As stated in the report, "The planning process, which included extensive engineering studies and an assessment of the biological and environmental data accumulated during the study period, did not uncover any irreversible actions or drastic effects on the area environment."

The consensus of opinion is that no real or substantial injury, damage or adverse effect will result from the proposed diversions. No significant changes in the hydrology, water quality or general ecology is expected in the main system of the Connecticut River.

I would recommend that the American Water Works Association generally endorse the concepts identified in the report with regard to the ecological, environmental, and public health aspects of the various proposals.

It is also recommended that appropriate action be taken if future studies reveal the risk of any adverse environmental impact.

Very truly yours,

Allan Grieve

Allan Grieve, Jr.
Director of Water Division and
Chief Water Supply Engineer.

AG/AM

STATE OF NEW HAMPSHIRE
CONCORD 03301

OFFICE OF GOVERNOR

DIRECTOR OF COMPREHENSIVE PLANNING

December 13, 1972

Mr. John William Leslie
Chief, Engineering Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

The Draft Environmental Statement relative to The Northfield Mountain and Millers River Basin Diversion proposals of the Northeast Water Supply Study has been reviewed by this office, and we concur with the Statement as written and have no additional comments.

As the designated State Clearinghouse under the provisions of Circular A-95, we distributed the Statement to other interested state agencies for their review. Enclosed are copies of the responses and comments we have received.

Sincerely,

Alexander M. Taft

Alexander M. Taft

AMT/as

Enclosures

# STATE OF NEW HAMPSHIRE

**INTER-DEPARTMENT COMMUNICATION**

**DATE** November 27, 1972

**FROM** Mary Louise Hancock, Director
Office of State Planning

**AT (OFFICE)**

**SUBJECT** Draft Environmental Statement for the Northfield Mountain and Millers River Basin Diversion Projects

**TO** Raymond P. Gerbi, Jr.

In view of the remoteness of this project and the absence of any tangible direct impact on the State of New Hampshire, we have chosen not to submit any formal review. Since nearly two hundred fifty parties were sent copies as part of the review process, we feel we can better expend our energies on other matters.

MLH:mb



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INTER-DEPARTMENT COMMUNICATION

DATE November 27, 1972

OM George Gilman
Commissioner

AT OFFICE Department of Resources & Economic Development

Office of the Commissioner

JECT Preliminary Draft Environmental Statement for: The Northfield Mountain and Millers River Basin Diverson proposals of the Northeast Water Supply Study

TO Raymond P. Gerbi, Jr.
Assistant to the Director
Office of Comprehensive Planning
State House

This Draft has been referred to staff and the Department offers no comment.

George Gilman
Commissioner

GG:c

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The State of New Hampshire

COMMISSIONERS

JOSE[illegible] [illegible]. GAULIN, P. E., CHAIRMAN
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JOHN W. YORK

Water Supply and Pollution Control Commission
Prescott Park
P.O. Box 95—105 London Road
Concord 03301

STAFF

WILLIAM A. HEALY, P. E.
EXECUTIVE DIRECTOR

THOMAS A. LA CAVA, P. E.
DEPUTY EXECUTIVE DIRE[illegible]
AND CHIEF ENGINEER

CLARENCE W. METCALF, [illegible]
DIRECTOR OF
MUNICIPAL SERVICES

December 26, 1972

Mr. John W. Leslie, Chief
Engineering Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

RE: NEDED-R

Dear Mr. Leslie:

Regarding the Northfield Mountain project, we have no comments as the entire project is apparently outside the jurisdiction of New Hampshire.

Regarding the Millers River diversion project, there appears to be no adverse effect on any waters within the jurisdiction of New Hampshire. We, of course, cannot commit the future use of those parts of the project area within New Hampshire jurisdiction.

Yours very truly,

Stephen W. Leavenworth, P.E.
Associate Sanitary Engineer

SWL/hyv

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Administration
STATEWIDE PLANNING PROGRAM
265 Melrose Street
Providence, Rhode Island 02907

January 2, 1973

Mr. John Wm. Leslie
Chief, Engineering Division
New England Division, Corps of Engineers
Department of the Army
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

This is to inform you that this agency has reviewed the Environmental Impact Statement for the Northfield Mountain and Millers River Basin Diversion proposals (reference NEDED-R) in accordance with OMB Circular A-95.

After having reviewed the proposals and having been in contact with other state agencies on the matter, we have no comments to make on the draft statement at this time.

Yours very truly,

Daniel W. Varin
Chief, Statewide Planning

DWV/TC/ln

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
JOHN F. KENNEDY FEDERAL BUILDING - BOSTON, MASSACHUSETTS

January 12, 1973

Mr. John W. Leslie, Chief
Engineering Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

We have reviewed the draft environmental impact statement for Northfield Mountain and Miller's River Basin Water Supply Projects. We are concerned about the impact of this project on the Quabbin Reservoir and the suitability of the water quality of the rivers involved in this diversion.

The Environmental Protection Agency would like assurance that the turbidity of the water entering the Quabbin Reservoir will be low. The final impact statement should state how turbidity will be monitored and controlled. We recommend that turbidity units not exceed five Jackson units. We agree with the Massachusetts Department of Public Health Directive which recommends that diverted waters be chlorinated prior to the entry into Quabbin Reservoir. The final statement should indicate the proposed effectiveness of the chlorination in reducing pollution loads and should indicate how other impurities untreatable by chlorination, will be controlled.

Pollution abatement plans for the Connecticut River are important in controlling the introduction of pathogens into the reservoir. In order to guarantee the purity of Quabbin Reservoir the final impact statement should indicate modifications in the proposed project that will be made if the water quality is not found suitable for diversion in 1976.

In order to provide maximum resident time and maximum dilution, we recommend the discharge of diverted waters in the western branch of the reservoir. By doing this, the discharge point will be a maximum distance from the withdrawal point. If the diversions are discharged in the middle branch, we feel that there is a chance

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of water short-circuiting the withdrawal point, thus minimizing natural purification benefits.

The project should include the use of a monitoring device to measure radioactivity. We are concerned about the possibility of an accidental spill during times of diversion. The final statement should indicate the method that will be used.

We have been assured that there will be little fluctuation in the river level since water will be diverted only during times of maximum flow. The final statement should give more detail on this subject by assessing the effect of this project on fisheries downstream. Until we receive this detailed information in the final statement, we cannot assess adequately the environmental harm created on the river itself.

We are looking forward to reviewing the final impact statement.

Sincerely yours,

Joan Harrison

Joan Harrison
Environmental Impact Coordinator

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THE ASSISTANT SECRETARY OF COMMERCE
Washington, D.C. 20230

December 28, 1972

Mr. John W. Leslie
Chief, Engineering Division
Department of the Army
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

The draft environmental impact statement for The Northfield Mountain and Millers River Basin Diversion proposals of the Northeast Water Supply Study, which accompanied your letter of November 13, 1972, has been received by the Department of Commerce for review and comment.

The Department of Commerce has reviewed the draft environmental statement and has the following comments to offer for your consideration.

It is not explicit whether the Miller's River plans are included in the Connecticut River diversion impacts given in Table 1 (p. 58). Is the Miller's River diversion included with the Connecticut River diversion in Figure 1?

In the discussion of public health aspects (pp. 43-48) mercury analyses are reported for the Connecticut and Miller's Rivers but not for the Tully River or Wachusett Reservoir. Pesticide analyses are reported only for the Connecticut River.

The section on the use of weather modification as an alternative to the proposed action is generally well covered. We have three rather minor comments specifically related to this section.

(1) Page 115, third paragraph, line 5

Substitute "National Oceanic and Atmospheric Administration" for "United States Weather Bureau."

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(2) Page 116, second paragraph

Evidence gained through National Oceanic and Atmospheric Administration (NOAA) research suggests that winter cloud systems over Lake Erie may be modified to produce additional precipitation. This will not alter the conclusions reached by the Corps of Engineers, namely, much research remains to be done to improve the state of the art of weather modification and, at present, reliance upon cloud seeding is not the best solution to problems of augmenting Eastern Massachusetts water supply. However, the Corps of Engineers should be aware of proposed NOAA weather modification research in the Great Lakes Basin.

(3) Page 117, first paragraph, lines 8-9

Suggest rewording along the lines, ". . . most precipitation would be taken up by plants and soil."

We hope these comments will be of assistance to you in the preparation of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

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OFFICE OF THE DIRECTOR

# United States Department of the Interior

BUREAU OF MINES
WASHINGTON, D.C. 20240

December 20, 1972

ER-72/1345

Memorandum

To: Chief, Engineering Division, New England Division, Corps of Engineers, Waltham, Massachusetts

Through: Assistant Secretary--Mineral Resources DEC 29 1972

From: Director, Bureau of Mines

Subject: Preliminary draft environmental statement, Corps of Engineers, Northfield Mountain and Miller's River Basin Water Supply Projects of the Northeast Water Supply Study, Franklin, Middlesex, and Worcester Counties, Massachusetts

We have reviewed the preliminary draft environmental statement concerning possible water supply proposals under consideration for the purpose of providing water to the Boston Metropolitan District. The statement is a general treatment of the potential impact from obtaining a supplementary water supply from four alternate sources via Northfield Mountain and Miller's River water basins. The supplementary supply would be diverted into the existing Quabbin Reservoir.

Mineral production in the general area of the project includes sand and gravel and stone. In 1970, production was valued at $1.5 million in Franklin County, $13.8 million in Middlesex County, and $4.0 million in Worcester County. Soapstone as well as feldspar and other pegmatite minerals have been produced in the area, although there has been no production in recent years. There are also inactive lead, zinc, and graphite mines in the vicinity of Tully Mountain.

Tunneling, as proposed in the project, might have some impact on the mineral resource potential. The environmental statement should include a section on the geology of the region. It is suggested that such a discussion be included in Section II, Environmental Setting Without the Project. Then, Section III, Environmental Impacts on the Proposed Action, could discuss

Memo. to Chief, Engineering Division, New England Division, Waltham, Massachusetts, Subj: Northfield Mountain and Miller's River Basin, Massachusetts

any environmental impacts caused by construction. Although we do not believe the project will have any major impact on mineral resources or mineral activities, we believe a brief discussion of geology and possible mineral involvement is necessary for the statement to be complete.

Paul Zinner

Acting Director PAUL ZINNER

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
FEDERAL BUILDING
1421 CHERRY STREET
PHILADELPHIA, PENNSYLVANIA 19102

IN REPLY REFER TO:

27 DEC 1972

Mr. John Wm. Leslie
Chief, Engineering Division
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Mr. Leslie:

Mr. Bruce Blanchard, Director of the Office of Environmental Project Review, U.S. Department of the Interior, has asked us to reply directly to your November 13, 1972 letter with the Bureau's comments on the preliminary draft environmental statement for the Northfield Mountain and Millers River Basin Diversion proposals of the Northeast Water Supply Study.

The draft statement has in most instances addressed the technical and hydrologic consequences of implementing diversion of Connecticut River and Millers River water into Quabbin Reservoir to augment the municipal water supply for Metropolitan Boston. Unfortunately, with the exception of limited discussion of the environmental effects of reduced river flows and the short term effect of reduced water supply for urban Massachusetts, it has largely failed to identify and assess recreation and open space related environmental consequences of the proposals.

In regard to the Northfield Mountain, the draft statement fails to mention the effect of the proposed water supply diversion on the recreational features of the project which are included in Exhibit R of the current application to the Federal Power Commission for an operating license. Copies of the Department of Interior's comments of January 14, 1972 (FPC #1889)

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and of February 14, 1972 (FPC #2845) have been enclosed for your information as part of this response. While the Federal Power Commission has not acted upon these recommendations as yet, the pending nature of the license operation deserves special consideration in the environmental statement in regard to possible adverse or beneficial effects on recreation.

The statement's discussion of the Millers River Diversion fails to specify if additional reservoir clearing or vegetation changes due to protracted inundation will have any adverse effect of recreational facilities at Tully Reservoir.

The statement's references to transmission tunnels required for diversion do not provide sufficient detail to determine the environmental implications which might be associated with the construction or long term operation. These references in the statement should be expanded and furthermore should include consideration of mitigation measures to reduce visual and physical impacts, as required, for the length of the structure.

In the discussion of short term needs for augmenting water supply, the statement indicates that demand reduction techniques at the present time are ineffective yet the statement fails to consider the effect of supply rationing at present levels as a tool to stabilize interim growth of the region. Technically, no action is a single purpose alternative and the no growth aspect associated with such an alternative could provide a means of prolonging the utility of the present water supply system while allowing sufficient time to develop long term independent alternatives. At the same time, such action would represent an opportunity to consider and resolve socio-environmental problems which will be intensified indirectly by your alternative which assumes, encourages, and enhances the present rate of growth of Southeastern New England. We believe the statement should be expanded to include discussion of the impact such an alternative would have on prolonging the utility of the current water supply system.



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We have provided these comments to you for technical assistance purposes and we hope they will assist you in further developing your statement.

Sincerely yours,

Earl C. Nichols
Acting Regional Director

Enclosure

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United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

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F

RECEIVED - ...

D6119-1889

JAN 14 1972

3 - FEB 1972

Dear Mr. Plumb:

This is in reply to your letter of October 16, 1970, requesting our views and comments on a license application by the Western Massachusetts Electric Company for the Turners Falls Project (FPC No. 1889) located on the Connecticut River, Massachusetts. We have reviewed the licensing information and submit the following comments for your consideration and use.

The Department of the Interior has participated in the Connecticut River Basin Comprehensive Study as well as the Connecticut River National Recreation Area Study. We have also made an on-site inspection of the Turners Falls Project. Based on these studies, information provided by the applicant, FPC's 1968 Evaluation Report, and the Massachusetts Statewide Comprehensive Outdoor Recreation Plan, we find the applicant's Exhibit R to be deficient. The continued operation of the project should not have a significant adverse effect on the recreation use of the area, so we would have no objection to relicensing the project from a recreational standpoint provided that the applicant prepare an acceptable Exhibit R.

The outdoor recreation needs and potential of the project area have been documented in several studies and reports. Among these, the Connecticut River Basin Comprehensive Water and Related Land Resources Investigation indicates that only 25 percent of the recreation boating potential of impounded waters within the Connecticut River Basin is being utilized and that the recreation potential of hydroelectric projects is not being utilized. A significant portion of the present and future outdoor recreation needs of this region could be met through realization of the potential inherent in the Turners Falls Reservoir. The present Exhibit R does not contain a plan which adequately provides for optimum public outdoor recreation use of project land and waters.

We note that the Turner Falls Reservoir serves as the lower pool for the Northfield Mountain Pumped Storage Project (FPC No. 2485) and that the applicant states in the Exhibit R "this proposed Exhibit R augments proposals made under the Northfield Mountain project and the development of facilities is geared to complement and support a comprehensive plan approved by the Massachusetts Department of Natural Resources and the Federal Bureau of Outdoor Recreation." However, we find that the proposals incorporated in the license for the Northfield Mountain project provide for two actions that are directly related to the Turner Falls project: (1) the construction, operation and maintenance of the Four Mile Brook area, and (2) the acquisition of land for the Pauchang Brook area which is to be made available to the Commonwealth of Massachusetts. Due to local opposition we understand that the Four Mile Brook area is being proposed for deletion from the Northfield Mountain Project. Therefore, the remaining area in the Northfield Project will only partially assist in providing for the utilization of the full recreation potential of the Turners Falls Project.

Any license issued for this project should include the standard terms and conditions relating to recreation use and development that are contained in the appropriate FPC L-Form.

The Connecticut River in the project area supports large and small mouth bass, chain pickerel, walleye, yellow and white perch, northern pike, bullheads, channel catfish, crappie and carp. Upstream runs of the catadromous American eel, the anadromous American shad, alewife, Atlantic sturgeon and salmon are blocked by project dams. Brook, brown and rainbow trout inhabit the tributaries and are occasionally found in the main stem. The upstream portion of Turners Falls pond (the tailrace of Vernon hydroelectric plant) provides good trout fishing in the spring. Fishing pressure is moderate in the river reach from the dam upstream to "The Narrows"; northward the pressure is lighter and the Barton Cove area is fished heavily. Historically American shad ascended the river to the base of Bellows Falls, upstream from the project area. Atlantic salmon were able to negotiate the difficult rapids and ascended the river further upstream to Beecher Falls near Canaan, Vermont.

Public Law 89-304 approved October 30, 1965, authorized the Secretary of the Interior to initiate with the several states a cooperative program for the conservation, development and enhancement of the Nation's anadromous fish. As a result of this Act, the fish and wildlife agencies of the States of Vermont, New Hampshire, Massachusetts and Connecticut, the National Marine Fisheries Service and our Bureau of Sport Fisheries and Wildlife have been engaged in a coordinated program to restore the runs of American shad and Atlantic salmon in the Connecticut River since December 21, 1966. In this behalf, both a Policy Committee and a Technical Committee for Fisheries Management have been established under the terms of a formal agreement.

Several biological studies conducted by the Technical Committee have established that the Connecticut River provides suitable American shad and Atlantic salmon habitat upstream from Turners Falls Dam. Goals have been established for fish passage at each barrier dam in the river based on quality and extent of the upstream habitat. Engineering parameters for fish passage facilities have been developed for Holyoke, Turners Falls, Vernon, Bellows Falls and Wilder Dams.

The report on the Comprehensive Basin Study of the Connecticut River Basin now being considered by the Connecticut River Basin Coordinating Committee recommends that fish passage facilities be provided at five main stem dams including the Turners Falls Dam, to accomplish the objectives of the anadromous fisheries restoration program. The Secretary of the Interior, in cooperation with the Technical Committee for Fisheries Management of the Connecticut River Basin, has specified a 1973 date for completion of fish passage facilities at Turners Falls Dam.

The Policy Committee for Fisheries Management of the Connecticut River Basin has recommended that the instantaneous minimum flow released from the five major dams on the Connecticut River, Wilder, Bellows Falls, Vernon, Turners Falls and Holyoke be not less than 0.25 feet per second per square mile of drainage area (CFSM). Thus, the minimum instantaneous flow requirement for Turners Falls is 1780 CFS in order to develop and maintain the anadromous fish runs in this section of the river.

The pond facilities of the Turners Falls Project will be modified as described in FPC Order 541 to provide additional volume required for pump storage use. To accomplish this, bascule and tainter spillway gates will be enlarged to raise the pool 5.4 feet, thus deepening the shallow water areas of Barton Cove and degrading the waterfowl habitat found there. Raising the water level would not create a comparable amount of shallow water habitat elsewhere. The project otherwise will have no significant effect on wildlife.

The applicant's Exhibit S indicates that consideration is being given to the construction of a fishing platform downstream of Cabot Station. Provisions may have to be made for the closure of portions of the reservoir, river and power canal to fishing to insure fisherman safety at the project. The final decision on the feasibility of a fishing platform and possible special regulations regarding fishing in or adjacent to project facilities should be deferred until final operational procedures are implemented.

The recreational use plan is fully compatible with Exhibit S at the present time. As the impacts of pollution abatement and environmental protection and enhancement programs develop greater and more attractive opportunities for outdoor recreational uses, including those relating to fish and wildlife, both Exhibits R and S should be updated to meet increasing demands. We recommend that Exhibit S be amended to include provisions for periodic review in cooperation with the appropriate Federal and State agencies to determine future fish and wildlife development needs.

The project will not adversely impact on the mineral resources or the mineral industry. The project will not impact on any Indian lands under the jurisdiction of this Department. We believe the inclusion of the standard stream gaging article in any operating license will be satisfactory to us. However, the Turners Falls Project must be modified to provide fish passage facilities and a minimum instantaneous flow if the project is not to conflict with the on-going Federal-State program to restore anadromous fish in the Connecticut River. Subject to these requirements and the other Departmental concerns expressed in this review we do not recommend a Federal recapture of this license nor do we object to the issuance of a new license. We do make the following recommendations to the Commission:

1. The applicant be required to prepare a revised and acceptable Exhibit R prior to the issuance of any license. The revised plan should include the following:

   (a) Provisions for the immediate development of the facilities included in the three designated recreation areas: Cabot Woods, Branch Canal, and Unity Park.

   (b) Identify the additional lands at Turners Falls Reservoir which are required to help meet future outdoor recreation development needs at the project with an indication of the location, size and ownership of these lands.

   (c) The location, type and number of the various recreation facilities planned for future development.

   (d) Provisions for the development of boat access areas in the upper reaches of the Turners Falls Reservoir, particularly on the west bank.

(e) A plan for recreation development and use of lands in the 2.7 mile stretch of the river between the dam and Cabot Station Powerhouse.

(f) Provisions for biennial review and updating in cooperation with the appropriate Federal, State and local agencies to assure that acquisition and development are undertaken to meet the needs as they arise.

We further recommend that the revised Exhibit R be prepared in cooperation with our Bureau of Outdoor Recreation, the Massachusetts Department of Natural Resources, other appropriate agencies, and the licensees for the Northfield Mountain Project (No. 2485) to assure that the full potential of the project is realized and that the revised plan is consistent with the Northfield Mountain recreation proposal. In the event that the licensee does not own adequate lands to meet the future recreation needs at the Turners Falls Project, then in keeping with the Commission policy the Exhibit R should indicate the measures that will be taken to acquire and include within project boundaries enough land to assure the optimum development of the recreation potential of the project.

2. In order to provide for the conservation and development of the fish and wildlife resources it is requested that the license contain the standard conditions relating to fish and wildlife as contained in the appropriate FPC L-Form. The following special conditions are also recommended for inclusion in any license issued for this project.

(a) The licensee shall construct, operate and maintain or shall arrange for the construction, operation and maintenance of appropriate fish passage facilities at the Turners Falls Project by 1973 in accordance with the parameters set forth by the Technical Committee for Fisheries Management of the Connecticut River Basin. Final design drawings of the fish passage facilities shall be submitted to the Secretary of the Interior for approval prior to construction of the facilities.

(b) The licensee shall modify project operations as may be necessary to provide an instantaneous discharge of 0.25 CFSM (1700 CFS) through Turners Falls Dam as recommended by the Policy Committee for Fisheries Management of the Connecticut River Basin for purposes of developing and maintaining an anadromous fish run in this section of the Connecticut River.

At the time this licensing information was sent out for review by the Federal agencies the responsibility for carrying out the requirement of the Federal Water Pollution Control Act rested with the Department of the Interior. Since then this responsibility was assigned to the Environmental Protection Agency (EPA). To maintain continuity in the Federal review process we shall also list the water quality control concerns of EPA for your consideration and use.

The present water quality in the immediate area of the Turners Falls Project, although variable, is generally good and continues so as far downstream as the Holyoke Dam in Massachusetts. Downstream of this dam the water quality begins to deteriorate with a reduction in dissolved oxygen concentration and changes in other water quality parameters indicative of a degradation in water quality. The minimum level of dissolved oxygen concentration occurs in the vicinity of the Massachusetts - Connecticut State line.

The States of New Hampshire, Vermont and Massachusetts have generally classified the Connecticut River from its source to the Holyoke Dam as Class B. Below the dam the river is classified as Class C. Waters of B classification are suitable for recreation, including body contact sports, excellent fish and wildlife habitat and, after adequate treatment, public water supply. Class C waters provide for uses similar to those of Class B with the exception of water contact sports. Areas below the Turners Falls Project have been excepted from approval and are the subject of continuing negotiations.

The project operation in the past includes periods of much reduced or negligible discharge to reaches of the Connecticut River downstream of the project. In general, the impact of this type operation, during periods of low discharge, adversely affects the water quality by reducing natural recreation capacity of the stream, increasing concentrations of introduced pollutants, thereby increasing oxygen demand and by decreasing stream velocities which causes settling of suspended matter. Because of the demand for high quality water and for continual upgrading of present waters by more efficient treatment adequate streamflow is a vital consideration.

Water quality criteria for Class B waters of Vermont and Massachusetts require, in part, that the dissolved oxygen level be not less than 75 percent of the saturation level during at least 16 hours of any 24-hour period, and not less than 5 mg/l at any time. New Hampshire's criteria requires not less than 75 percent of the saturation level. Based on flow estimates at the Massachusetts-Connecticut State line, there is indication that by 1980 a flow of approximately 1500 CFS would be necessary to achieve this 75 percent level and by the year 2020 a flow of 3200 CFS will be required. Inherent in these estimates are assumptions that waste sources will be adequately treated by 85 percent removal of the oxygen demanding wastes and that all flows will be continuous.

Analysis of streamflow data for eight unregulated rivers in the Connecticut River Basin indicates that the average 60-day low flow with a 10-year return period amounts to 0.19 CFS of flow per square mile of drainage area (CSM). On a similar basis the 90-day flow averages 0.22 CSM. We believe that a flow equivalent to 0.2 CSM represents a low flow which could reasonably be expected under most natural conditions.

In view of the relationship of the project and its potential effect on downstream water quality and the maintenance and enhancement of long-term uses which will be provided by high quality water, it is recommended that the license include provisions which would permit the establishment of specific flow requirements as follows:

> The Licensee shall, in the interest of maintaining water quality in the Connecticut River, provide such facilities or modify operation as ordered by the Federal Power Commission upon the recommendation of the Massachusetts Division of Water Pollution Control or by the Water Quality Office of the Environmental Protection Agency after notice and opportunity for hearing.

As stipulated in Section 21(b) of the Federal Water Pollution Control Act of 1970, State Certification of reasonable assurance that applicable water quality standards will not be violated must be obtained within three years of the date of the Act (by April 3, 1973).



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We appreciate the opportunity to submit our views and comments on this license application by the Western Massachusetts Electric Company.

Sincerely yours,

(Sgd) W. W. Lyons

Deputy Assistant Secretary of the Interior

Honorable Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

RECEIVED - B.O.R.
22 MAR 1972

FEB 24 1972

Dear Mr. Plumb:

This is in reply to your letter of October 5, 1971, requesting our views and comments on an amendment to Article 41 of the Federal Power Commission license for the Northfield Mountain Pumped Storage Project (FPC No. 2485). The following comments are submitted for your consideration and use.

The outdoor recreation needs and potentials of the project area have been documented in several studies and reports. In our August 12, 1966, letter to you concerning this project we noted that the Connecticut River could be developed to provide outstanding outdoor recreation opportunities for the people in this heavily populated area. We further noted that the area lacked sufficient recreation facilities to meet the needs of the people and that the proposed Northfield Mountain pumped storage recreation development would help to satisfy these needs.

The Commission in Opinion No. 541, Opinion and Order Issuing and Amending Licenses for Project Nos. 1889 and 2485 (issued May 14, 1968) recognized the recreation importance of this project. Article 41 of the license for Project No. 2485 provides that the licensees shall expend $1,350,000 in the initial development of recreation resources and shall be responsible for the development of the Four Mile Brook area and shall purchase and make available to the Commonwealth of Massachusetts the land required for the Pauchaug Brook area. We understand that the land for the Pauchaug Brook area has been acquired by the licensees.

The proposed amendment to Article 41 would delete development of the Four Mile Brook area and would provide that funds be devoted to the development of other recreational resources. However, the proposed amendment does not designate a specific replacement for the Four Mile Brook area. Also we find that the licensees have not fully implemented Article 41 of the license by planning for and providing the additional initial developments required to meet demonstrated public needs at the project. In foregoing the Four Mile Brook recreation development, the recreational use plans for both Turners Falls and Northfield Mountain are affected since the planning at both of these projects was interrelated. We also believe there is an immediate need for recreational development in this area.

We recommend that approval of the Amendment to Article 41 of the Northfield Mountain license be conditioned with the stipulation that within six (6) months after the date of the approval the licensees will:

1. Provide a suitable replacement for the Four Mile Brook area.

2. Prepare an acceptable time schedule for the expenditure of the monies provided by the license for the acquisition of lands and development of facilities required for meeting the initial recreation needs of the project.

Emphasis should be given to the development of sites along the Connecticut River between the Massachusetts, Vermont, New Hampshire border and Turners Falls Dam, which are referenced on page 7 of Opinion No. 541.

We also recommend that the licensees prepare amendments to Exhibit R within one year of the date of the approval of Amendment to Article 41 to reflect, where appropriate, the following information:

1. The location of the lands planned for future development.

2. The location, type and number of various recreation facilities planned for future development according to anticipated demand.

3. A time schedule as to when these facilities will be provided.

4. Identification of the facilities shown for future development that are to be provided at the sole expense of the licensees and those facilities which will be provided in cooperation with others,

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5. The location of the facilities to enable the State Fisheries and Game Department to carry out the trout stocking program which was planned for the Four Mile Brook impoundment.

We further recommend that in implementing the stipulations suggested for Article 41 of the license and in preparing the amendment to Exhibit R the work be accomplished in cooperation with the Bureau of Outdoor Recreation, the Bureau of Sport Fisheries and Wildlife, the Department of Natural Resources of the Commonwealth of Massachusetts, other appropriate agencies and the licensee for the adjacent Turners Falls Project (FPC No. 1889). This cooperative planning effort will assure that these plans complement and are consistent with the recreation proposals at the Turners Falls project.

We wish to thank you for the opportunity to review the proposed Amendment to Article 41 of the license for the Northfield Mountain Pumped Storage Project.

Sincerely yours,

(sgd) W. W. Lyons

Deputy Assistant Secretary of the Interior

Honorable Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426



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UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
U. S. POST OFFICE AND COURTHOUSE
BOSTON, MASSACHUSETTS 02109

JAN 5 1973

Division Engineer
New England Division
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Sir:

This letter constitutes our review of your preliminary draft environmental statement entitled, "The Northfield Mountain and Millers River Basin Diversio Proposals of the Northeast Water Supply Study."

Our comments were prepared in response to a letter from the Chief, Engineerin Division, dated 13 November 1972, and do not represent review comments of the Department.

Our comments are as follows:

1. Project Description

Alternative No. 2 - Tully-Millers Diversion

The section should include a statement to the effect that the control flows, (tables on pages 21 & 22), are estimates, not permanently set, and may have to be adjusted when the project is implemented. Control flows should be discussed for Tarbell and Priest Brooks and incorporated into the environmental statement.

Alternative No. 3 - Tully Complex Diversion

Define: cleared, grubbed and stripped. The layman may not have a clear understanding of these and other words. A glossary would be helpful.

2. Environmental Setting Without the Project

Northfield Mountain Diversion - Connecticut River Basin

This section should discuss the important sport fishery which exists in the lower river from the estuary to Holyoke Dam. Commercial fishing is primarily in that section below Hartford, Connecticut. The discussion should mention that the fish lift at Holyoke Dam has passed shad since 1955, but is inadequate to handle larger runs of salmon and shad in the future. The section should mention that a technical committee for the fisheries management of the Connecticut River Basin, formed in 1967,

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is primarily concerned with the restoration of anadromous fish. The committee is made up of representatives from fish and game departments of Connecticut, Massachusetts, Vermont and New Hampshire, and the Bureau of Sport Fisheries and Wildlife and National Marine Fisheries Service.

Millers River Basin

This section should discuss the excellent trout habitat and fishing, the abundance of furbearers and other wildlife that were historically associated with the Millers River. It should be mentioned that with pollution abatement, parts of the Millers would provide an outstanding trout fishery.

3. Environmental Impact of the Proposed Action

This section should include a discussion of siltation effects in the immediate and downstream areas during project implementation; qualitative and quantitative evaluations of the wildlife habitat that will be lost by construction of the diversion tunnels or other project structures; and any methods that will be used to minimize the aforementioned adversities.

Northfield Mountain - Connecticut River

Pg. 38. The last two sentences can be deleted since there is no known fish passage facility design parameter which would effectively stop the migration of lamprey eel. In addition, passage of lamprey eels into Quabbin does not present major problems to fisheries management.

Alternative No. 1 - Millers River Mainstem

2nd paragraph - "Wetlands by their definition are wet all year round so that no impact would be expected on them," should be changed to read "Wetlands by their definition are lowlands covered with shallow and sometimes temporary or intermittent waters, and no significant impacts are expected."

Alternative No. 2 - Tully-Millers River Diversion

Pg. 51, 2nd paragraph, "It is expected that...Alternative No. 1". Should be changed to indicate that the environmental impacts on the Tully and East Branch Tully Rivers may be more significant than on the Millers River due primarily to differences in water quality and aquatic resources.

Alternative No. 3 - Tully Complex Diversion

(1) Tarbell Brook Diversion: This discussion needs more consistency with the project description. Pg. 26, 1st complete paragraph. Does the 28-acre pool inundate 40 acres of wetland or is the 40 acres inundated in addition to the 28-acre pool?

(3) Tully Reservoir Diversion

Pg. 53, 3rd paragraph. "Less than 50 acres....project would increase." Should be changed to read "Approximately 50 acres of valuable upland game habitat would be lost. Fishing and boating values associated with this project are expected to increase.

Pg. 54, 1st paragraph. "This 1/2-mile stretch of trout.....marginal waterfowl area." Clarify "replace". The trout stream will be physically replaced but the economic and aesthetic values are entirely different.

4. Adverse Environmental Effects Which Cannot be Avoided Should the Project be Implemented

We recommend that the list of adverse environmental effects be expanded to include the destruction of fish and wildlife habitat, and the environmental degradation resulting from urbanization by delivery of this resource.

5. Alternatives to the Proposed Action

Water Demand Control
B. Methods of Controlling Demand

This section should be expanded to include intensive water conservation programs for the public.

6. The Relationship Between Short-Term Uses of Man's Environment and the Maintenance of Long Term Productivity

No comment.

7. Irretrievable or Irreversible Commitment of Resources

The last paragraph is inappropriate and should be deleted.

8. Coordination With Other Agencies

No comment.

Sincerely yours,

Richard E. Griffith

Regional Director

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United States Department of the Interior
NATIONAL PARK SERVICE
NORTHEAST REGION
143 SOUTH THIRD STREET
PHILADELPHIA, PA. 19106

IN REPLY REFER TO:

L7619
NER(CF)

DEC 26 1972

Mr. John William Leslie
Chief, Engineering Division
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

Thank you for the opportunity to review the preliminary draft environmental statement for the Northfield Mountain and Millers River Basin Diversion forwarded with your memorandum of November 14.

First, we note a few minor points of an editorial nature. On page 4, we suggest adding "ability of" to the end of line 7. On page 7, we suggest that a source from which the reports of the two environmental consultants can be obtained be listed for the convenience of reviewers who may wish to obtain them. Also, we were well into the preliminary draft before we realized that Northfield Mountain was not an alternative for one of the three Millers River diversions, but is coupled with one of them, and suggest that this point be made clear early in the statement. Finally, we feel that the statement made on page 38 that the bulk of the river's nutrient load is picked up downstream of the diversion point should be documented.

Of more concern to us are three other points. First, while we note that you have consulted the National Register of Historic Places and found that no sites listed therein will be affected, we urge that you contact the State Liaison Officer for Historic Preservation, Honorable John F. X. Davoren, Secretary of the Commonwealth, Chairman, Massachusetts Historical Commission, Office of the Secretary, State House, Boston, Massachusetts 02133, to assure that no sites being considered for addition to the Register are affected.

Second, while it is outside of our field of expertize, we suggest inclusion of more data on the possible impact of the diversion tunnels. How many cubic yards of spoil will be produced? Does disposition of this spoil create impacts? Will tunnel construction affect ground water levels or local drainage patterns and thus possibly affect localized ecological communities?

Finally, though again the subject is outside of our primary area of concern, it seems to us that the long-range potential impacts of inter-basin diversion should be discussed. If the recommendation is implemented, and the analysis of alternatives is correct, the Boston Metropolitan area will gain an additional one hundred million gallons per day of water cheaper than it could by any other method. This will permit additional growth in the Boston Metropolitan area, and thus will have a profound, if somewhat indirect effect on the environment.

Conversely, implementation of the project will remove one hundred million gallons of water per day from potential use within the Connecticut Valley, again with a profound potential impact.

We realize that an in-depth assessment of these impacts is probably not possible. We also realize that the decision as to whether or not the inter-basin diversion should be made does not lie with the Corps. Still, we feel that these long-range but profound potential impacts should at least be mentioned in the draft.

Sincerely yours,

Eugene G. Parisho

Eugene G. Parisho

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OFFICE BUILDING HARTFORD, CONNECTICUT 06115

December 21, 1972

Mr. John Wm. Leslie
Chief, Engineering Division
Department of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

Subject: Preliminary Draft Environmental Statement of the Northfield Mountain Water Supply Project on the **Miller's River Basin Water Supply Project**

## Introduction

The Department of Environmental Protection (DEP) is gravely concerned about diversions from the Connecticut River outside of the river basin. DEP wishes to express its concern on this Northfield Mountain/Miller's River Basin Water Supply Projects, as the State of Connecticut did in 1931 with the diversion of the Swift River. We believe no State Legislature should have the sole right to determine the extent of diversions from a river which flows through other states downstream. For this reason DEP believes that a regional group should be empowered to (1) determine what is the maximum amount of water that can be diverted from the Connecticut River Basin based on the requirements of the river, the dependent eco systems and the people who live along it, and (2) allocate that amount of "divertable" water amongst states by criteria acceptable to all parties involved. DEP feels that the existing New England River Basins Commission can serve this function.

DEP's concerns about furthering the precedent of upstream diversions can be seen most clearly on Figure 1, P. 63. Quabbin and the Swift diversion started in the 1930's and according to Figure 1, it will run dry around 1984 or a period of about 50 years, a half-century. However with the proposed Connecticut diversion only, the end of Quabbin is only prolonged by about eleven years, a decade. Even with the most optimistic figures including the Tully diversions, the fate is prolonged only two decades. Clearly these are only short-term solutions. DEP's concern is that this action is a precedent for future diversions out of the Connecticut River Basin for which no impacts or controls have been discussed or dealt with, and no ongoing mechanism has been set up to handle these questions amongst states.
Therefore DEP requests that this action be stopped until a regional body such as the New England River Basins Commission can meet and develop solutions equitable to all parties involved.

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*This paper was produced from recycled paper - both broke and sound.*

In addition DEP would like to comment on the Preliminary Draft EIS by section. Our policy on the review was to consider only the points involving the State of Connecticut as there are ample reviewers from other States.

Section 1. This section is inadequate. The CEQ guidelines require that the EIS consider the overall cumulative impacts including future actions planned. DEP feels a clear statement should be made of how much water is expected to be taken in the future. This "flood-skimming" of the Connecticut River is a precedent for future action.

One area which was not covered was the administration of the water diversions. It is unclear whether the Corps will be in charge or not. Further, what control procedure will be used to insure that flood skimming only occurs on days when the minimum flows have been reached?

Section 2. No Comment

Section 3. What will be the impacts of future actions for which this is a precedent? If we continue to take incremental quantities, each diversion will be a decrease of perhaps acceptable relative amounts; however the concern should be what is the maximum amount of water which can be diverted and yet still have a healthy river. Environmental effects would be one factor in that determination.

Why was 17,000 CFS chosen as the lower limit of flow acceptable for skimming? Was this determined by projected demand for water, or were ecological reasons included? Is the Corps required to follow a State legislative mandate? DEP feels a much broader and greater number of flow levels should be evaluated. As indicated later in the EIS, this is not "flood skimming". The highest recorded CFS on the Connecticut River is in the 200,000 range. From an environmental standpoint, if 17,000 is better than 12,000, wouldn't 20,000, 25,000 or 100,000 be better than 17,000?

Socio-Economic Impacts

The analysis is too narrow. What costs will be associated with the greater concentration of pollutants in Connecticut (P.79)? Further the analysis only considers the costs and benefits to Massachusetts, but not the costs to Connecticut. This must be corrected. In addition, from a water supply standpoint, what will happen when Hartford must use Connecticut River water? The need is forecasted for before the year 2000. Hartford, however, will return the water to the river basin. What is the source data for the costs on the no go option (P. 106)?

Section 4. No discussion of impacts caused by future diversions for which this is a precedent because this project is only a short-range solution.

Section 5. In the case National Resources Defense Council, Inc. v. Morton, ____F.2d__, 3 ERC 1558 (D.C. Cir. 1972), the court found that ". . . the discussion of environmental effects of alternatives need not be exhaustive. What is required is information sufficient to permit a reasoned choice of alternatives so far as environmental aspects are concerned. As to alternatives not within the scope of authority of the responsible official, reference may of course be made to studies of other agencies--including other impact statements." (Emphasis added)

No Action. Only losses were considered. Benefits should also be considered.

Desalination

As stated on P. 121, desalination could be a long-range solution to the M.D.C.'s problems. However the analysis in this section gives it inadequate considera-ation. The costs and benefits were not delineated, nor were any benefits presented.

The fact that a long-run solution was found would be a major benefit in itself. The present proposal is only a short-range solution--in ten years the problem will have to be dealt with again. Further the cost of water from the proposed plans is artificially low because M.D.C. is not paying for any costs caused by the diversion downstream. With desalination the people getting the benefits would also have to pay the costs.

Importation. No Comment

Waste Water

It is mentioned as a potential source of industrial water, but then is left insufficiently developed.

Ground Water

No cost/benefit figures were presented, so outside observers could not make a rational choice.

Dual Water Supply Systems

Insufficient information is given on costs and benefits.

Other Diversion Sites

A. No Comment

B. Merrimack River. Again costs and benefits are inadequately presented. This appears a reasonable choice for two reasons: (1) there is potential for long-run water supplies and (2) the river is closer to those who will benefit by the diversion.

Sudbury. Same inadequacies as above.

Water Demand Control

A. The data on the user area is inadequate. The EIS says national data is quite different than this region.

B. Were any efficiency studies done to determine how much of the current water is wasted in the MDC area? An educational campaign could reduce that segment and decrease future demand requirements. Modification of new construction building codes should have been considered. DEP agrees the present elasticity data is weak; however since the Army Corps is involved in several water supply projects, it should fund some water elasticity studies.

Since the Corps is involved with federal funding, some alternatives may be chosen, not because they are the best, but because outside funding is available only for certain options. Which of the alternatives presented would the Corps help finance and which ones not?

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Was any consideration given to a water rate which increases with water consumed? This is an alternative that should be considered.

Restrictions

The analysis was not developed fully. As we have seen, growth has costs as well as benefits.

Release Schedules. No comment

Population Zoning and Regulations

The definition as well as the analysis of this area is inadequate.

Section 6. Donor and receiver systems are in Massachusetts, but any damage to the river would occur downstream. A cost/benefit analysis should be presented.

Section 7. DEP feels these diversions are permanent considering projected future shortages in 10-20 years. Further, this is an irreversible commitment of future diversions from the river basin since no ceiling has been determined for the river.

Conclusion

DEP reiterates its position that this is an action which definitely sets a precedent for future diversions out of the river basin. Furthermore the DEP feels that this project should be held up until a regional agency such as the New England River Basin Commission can be empowered to determine the allowable amount of water that can be diverted from the Connecticut River and to allocate that quantity of water amongst the states in a mutually agreeable way.

At your service,

Dan Lufkin

Dan W. Lufkin
Commissioner

DWL:bw

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*The Commonwealth of Massachusetts*

*Department of Commerce and Development*

*State Office Building, Government Center*
*100 Cambridge Street, Boston 02202*

FRANCIS W. SARGENT
Governor

THOMAS I. ATKINS
Secretary
Communities & Development

DANIEL P. MCGILLICUDDY
Acting Commissioner

727 3221

November 15, 1972

Mr. John W. Leslie
New England Division
Corps of Engineer
424 Trapelo Rd.
Waltham, Mass. 02154

RE: Preliminary draft - Environmental Statement, NEWS, Southeastern New England.

Dear Mr. Leslie:

I have had Mr. Regis J. Harrington, our Director of Area Planning, review the above identified draft statement which I received from you on November 14, 1972. We find that overall the draft statement is quite comprehensive. However, it is our feeling that the draft statement is weighted to a very great degree on the side of hydrologic parameters and a mere, so called, "brush treatment" given insofar as the economic factor are concerned in the overall environmental framework.

We feel that not enough emphasis is given to the possible economic impact portion of the environmental statement. From our point of view, this can only mean that either the Corps does not have any qualified economists on their staff or, as a matter of policy, it has been determined that the economic affects of such a proposal need not be emphsized. I wish to assure you that this Department's policy certainly emphasizes that all aspects of the environment of any project should be considered seriously. We still feel that the general public must recognize the importance of the economic aspects of any environmental statement. We all know that the "Good Life" aspects of the environment are extremely important but at the same time we should all recognize the importance of retaining and, if possible, expanding the economic base of the area in order to pay for the costs of maintaining and improving the ecological aspects of the environment.

I would therefore recommend that additional emphasis be placed upon the beneficial economic aspects of any of the alternatives described in the preliminary draft.

Sincerely,

Daniel P. McGillicuddy

Daniel P. McGillicuddy
Acting Commissioner

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In reply to the Preliminary Draft Environmental Statement Northfield Mountain Water Supply Project--Miller's River Basin Water Supply Project", I wish to make the following comments:

(1) Few references to other persons' work (or works) are made, in the entire statement. In my estimation, no engineers could have prepared many of the biological comments without reference to biologists' work. Lack of citations prevents ease of a third person's checking any data given or statements made.

(2) The population growth figures are already out-dated and too great. (See Rosenthal, Jack. Census Estimate at Century's End Cut by 20 Million. The New York Times, Dec. 18, 1972:p.1.)

(3) Granted, the area is vulnerable to water shortages in drought periods, but I submit that it is those people who live in the so-called "water-rich" areas of Massachusetts who are restricted in their use of water at such times, while those who live in Metropolitan areas largely ignore any environmental crisis.

(4) Page 12, paragraph 4; concerns land requirements for the proposed diversion through Northfield Mountain Pumped Storage Facility. Question arises about the item "5 acres for rock excavated from the tunnel"--Will the plans leave the rock simply dumped somewhere, creating a 5-acre moonscape? Also, what effect will the removal of sub-surface rock have on the surface? This in itself needs detailed study.

(5) Page 13, paragraph 2; Just because the potential of diversion from the Miller's River to Quabbin was realized in the 1920's and 1930's, is no valid reason for carrying out this plan today and compounding the errors of "historical precedence."

(6) The effects of diversion on communities which abut the Connecticut River and are located south of the proposed diversion are not adequately dealt with. A number of these communities depend on flood plain wells for their water supplies now. Diversion will have an adverse effect on the annual recharge of these wells and a potentially disastrous effect on these communities.

(7) Page 37, paragraph 2; The value of fish other than those species important to anglers is not considered, but it is precisely these species which play an important part in the food web which sustains the sport species. The eggs and young of minnows and suckers may survive the Northfield facility pumps, but they will then be released to other water ways in poor condition. Thus they will be removed from their own "food web" where they are important as food for sport fish, and will be dumped elsewhere, where (a) they may not find their own food and (b) may become a pollutant themselves on decomposition.

(8) It is impossible to accept the statement (page 50, paragraph 3), "No changes are predicted for vegetative cover..." when later in the same paragraph it is admitted, "Higher areas which presently receive water infrequently, probably will receive shorter periods of inundation." The vegetative cover is highly dependent on not only average amounts of water, but on duration and season of water availability.

(9) Page 52, paragraph 1; Tarbell Brook Diversion--
The seasonal inundation of 40 acres of wetland to a depth of 5 feet will, I predict, create a mudflat bare of vegetation during the alternate season. This would promote erosion and siltation.

(10) The greatest part of the statement deals with the question of water quality and public health of the receipient areas, but these questions should also be considered for the donor areas--what will happen to the water quality of the donor areas, should diversion occur?

(11) Page 61. The no-diversion alternative is, on the contrary, the most realistic. The present system of operation of the MDC must be changed radically before the resources of western Massachusetts and, indeed, all the western New England area are funnelled helter-skelter eastward. The MDC at present must add any community to its system which chooses to join, provides the piping and guarantees purchase of an agreed volume annually. This creates a poor attitude toward water use. Because the communities must purchase a guaranteed volume, the local water resources are abandoned. There is a growing attitude of let "Them" take care of the problem. A few telephone calls recently confirmed what I had suspected--that we who live in the "Water Rich" part of this state pay generally higher water rates than do those in the "water poor" areas (eg., Holyoke's redidential water rate is 70¢/1000 gals.). Differences are made up through taxation and bonding--"hidden"charges. This, too creates in the average citizen an illusion that water is "cheap" and can therefore be wasted without concern.

The Summary Sheet at the beginning of the Draft Statement lists a number of alternatives available for expanding the MDC water supply. Many have been eliminated from consideration because of "cost". The fact of the matter is that the only reason diverted water would be cheaper in terms of dollars is that it is simply taken without dollar payment. While the so-called "donor" area suffers inevitable environmental damage and potential future social and economic damage because its resources are diverted to enrich another area.

There must be an immediate return to use of local resources before any more water is diverted. In addition, desalination and waste water re-use programs must be examined for implementation. Future sewage building programs must separate sanitary sewers from storm sewers, so that storm water can be utilized. Building codes must be changed to encourage installation of the newer toilets that use far less water per flush as a means of water demand control.

We have long accepted the fact that water is a limiting factor for plants and animals. It is also a limiting factor for man. We are now beginning to see the wisdom of limiting the numbers of people using park sites--the same principle must be accepted in cities. Population zoning and regulations are needed to preserve the environment of the metropolitan areas as well as the environment of the proposed "donor areas".

Laura M. Stickel, Environmental Quality Chairman
League of Women Voters of the Holyoke Area
82 Charon Terrace

LEAGUE OF WOMEN VOTERS
OF MASSACHUSETTS

120 Boylston Street
Boston, Massachusetts 02116
357-8380

December 28, 1972

Mr. John Wm. Leslie
Chief, Engineering Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Ref. NEDED-R

Dear Mr. Leslie,

The League of Women Voters of Massachusetts has reviewed the draft Environmental Impact Statement on the NEWS projects as they relate to the Northfield Mountain and Millers River diversions, and we have a few comments to make.

We recognize that any alteration of a natural system will have animpact, most frequently a negative one. We recognize that man's role in the natural system will always require some accommodation. We recognize that the alternative of no diversion in the subject situation is probably unreasonable under present constraints on population zoning as an alternative. What we question is the somewhat unbalanced values assigned to donor and receiver issues -- is the loss of a lawn any more traumatic to an MDC user than the loss of a trout stream to a Tarbell Brook resident? Fish and grass are desirable though not necessarily equal elements of man's environment.

NEPA requires exploration of all possible alternatives to a proposed project, including the alternative of no project. We feel that some of the alternatives are rejected without benefit of the depth of analysis and research given to the proposed diversions.

1. Re water demand control, are nationwide figures on categories of water use comparable with categorical uses in the MDC communities? Is Akron, Ohio's domestic use percentage breakdown a valid indicator of MDC use patterns? We realize that, for the purposes of the NEWS study, figures were not available to determine how much MDC water is used by whom and in what manner, but we believe that these statistics must be developed before the alternative of demand control is negated. (We regret that use categories were not measured as diligently as shad eggs.)

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2. Re pricing restraints, is the Seidel & Baumann assessment of the minor effect of rate adjustment on demand relevant to MDC? MDC users have been castigated for not paying their water's worth, when in fact they do and then some, for the difference between cost and price is paid through MDC assessments on local taxes with the addition of an annual share of the deficit financing that characterizes MDC Water District management. Because this overpayment is not immediately obvious to the customer, water is not regarded as the limited resource in need of conservation that it really is.

A telephone survey that determines that only 8% of MDC water is used industrially does not tell us how much of that use does not require this high-quality water - we note that this 8% of projected demand just about equals the 48 mgd that would be diverted via the Tully Complex Alternative #3.

The MDC is engaged in a recently-authorized study of its water supply system. We would hope this study (which contains some of these elements of concern to us) could be completed and its results analyzed before commitment is made to further diversions to Quabbin.

3. On reuse of water, another MDC study is focusing on the future of the sewerage system. Hopefully it will find a way for member communities to assist in the natural cycle of water use, discharge, recharge, and reuse, thus enabling members to draw more responsibly on their local resources instead of pouring millions of gallons into Boston Harbor and reaching out for fresh supplies from someone else's backyard.

It may well be that in the long run the proposed diversions are the only reasonable means of serving the MDC system which supplies 40% of the state's population and is under pressure to serve more. We have stated before and we repeat here our belief that a justified need must be met. The waters of the Commonwealth belong to all its people, and Massachusetts as a whole benefits from the economic, environmental, and social vitality of any one of its regions. Such developments as transportation systems, hospitals, and institutions of learning are carried out statewide with statewide support; resource needs must be met in like manner. Our concern is that not enough specifics have been dug out about use patterns in the MDC area to make a balanced judgement possible.

Probably the most dramatic statement of impact is that even with the proposed Connecticut and Millers diversions, Quabbin in 1998 will have reverted to its present volume and begun to

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deteriorate. That's a lot of activity only to find oneself in 25 years back where one started. To continue diversions without imposing responsibility on users merely continues the illusion that there's plenty more where that came from and it's cheap. In view of the magnitude of the proposed projects and their relatively short-term effectiveness, the League hopes that more work can be done in the areas described above before further diversion commitments are made.

Very truly yours,

Margaret Lynch

Mrs. Charles E. Lynch
President

Rita Barron

Mrs. Rita Barron
Water Resources Chairman

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CLEAN WATER

LAKE COCHITUATE WATERSHED ASSOCIATION, INC.
1143 WORCESTER STREET, NATICK, MASSACHUSETTS 01760

Kindly reply to: 61 Lake Shore Road, Natick, Mass. 01760

December 20, 1972

NEWS Study
U.S. Army Engineeer Division, New England
424 Trapelo Road
Waltham, Massachusetts 02154

Gentlemen:

The Lake Cochituate Watershed Association has evaluated your November 1972 preliminary draft environmental statement on the Southeastern New England (NEWS) Study, and recommends several additions and changes.

On pages 137 through 150, your report addresses itself to the possibilities of Water Demand Control. We appreciate the addition of this consideration to your study, as it represents the other half of the supply-demand equation which hopefully will stay better balanced in future years. And, as vividly depicted by your page 63 graph: "Projected Quabbin Reservoir Volumes with and without Diversions", planning without this half of the equation merely (but at great expense) forestalls the inevitable confrontation. These comments of ours are now supported by the November 1972 Reports of the Mass. Citizens Task Forces on Environmental Reorganization, specifically Concern 6, "Master Planning for Water Supply", discussed by the Water Resources Task Force on pages 328 and 330 of that report. We ask that these two pages be added to your report or its appendix.

In view of the importance of demand moderation action, we believe that your report's treatment of this subject area is superficial and weighted toward inaction. For example, your report indicates that 19% of water demand is used to carry away domestic wastes nationally, and suggests that an even greater percentage applies in the MDC user area due to low industrial demand. It would then seem significant to encourage the Sanivac waste-flushing system and others which might reduce flushing water demand by 90%, to discourage indiscriminate use of drinking-grade water, and to propose steps to accomplish these ends (revision of building codes, incentive tax techniques, etc.). Yet, under methods for controlling demand, you do not even list incentives for more efficient use techniques, let alone discuss them.

Similarly, we believe that a fifth category for controlling demand might be listed as public awareness programs - correction will only follow motivation, which follows awareness. Discussions of the implications of this comment are completely missing, although on page 155 the report quickly mentions (and then begs off from acting on) the ultimate need for population growth or water quantity restrictions if someone doesn't do something to

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moderate demand. Who, if not you and your study? When, if not now? What percent of total projected expenditure do you believe should go into positive demand-moderating programs?? Intelligent political decision-making must rely upon the degree to which you choose to treat these issues!

In this section of your report, greatest attention is devoted to increasing the price of metered supply. Your conclusion is that this alternative may have merit, but that much work remains to be done. By whom? Again, where are your suggestions regarding this? And why is your evaluation of the pricing system limited to linear increases, at still-too-low levels? If you wish to produce different statistics than those quoted in your referenced studies, why not suggest a waste-inhibiting price scale (base quantity per capita free, then quickly rising rates for luxury usage, for example)? But even in the studies quoted, a more positive attitude indicates a different approach: in the case of the privately-owned water company price increase (page 148), we do not agree that a rate increase should necessarily "be expected to result in a demand decrease" - not in view of the rising demand curves you have presented so well elsewhere. A lowered rate of demand increase would be more reasonable to expect. Did this company's use increase represent a decrease in this second derivative relationship?

Based upon the above comments, the LCWA urges that you include in your final report specific commitment to the finance and development of realistic demand moderation programs in parallel with supply projects, and that you temper your discussion and examples more accurately to this end.

Concerning an historical and less controversial matter, the LCWA recommends that you amend the discussion of Sudbury River water potential on page 136 of your report by the substitution of the following for the first paragraph:

"In 1846, the Cochituate Reservoir (previously Long Pond and presently Lake Cochituate) was acquired and developed to meet Boston's water needs through diversions from a subdivision of the Sudbury River watershed. In 1872, the Sudbury River Act was passed which authorized the diversion of a portion of the Sudbury River mainstream to the Boston Water System. Subsequent to this Act, a series of reservoirs was constructed by the Boston Water System and later by the Metropolitan Water District to further develop the watershed. Construction of the last reservoir in the basin was completed in 1898 and a total of 75.2 square miles of drainage area was controlled."

The LCWA appreciates the opportunity to interrelate with this important project.

Sincerely,

A. Richard Miller

A. Richard Miller
Executive Director

REPLY TO THE PRELIMINARY DRAFT ENVIRONMENTAL STATEMENT ON MILLERS-TULLY DIVERSION

The solutions ,or alternatives that the Corps have proposed are not long-range solutions to the water -supply and demand problem. They are a mere purchase of time, and folly which will deplete the watersheds of water necessary to their riverine environment.

T This preliminary draft environmental statement is not an honest assessment of the impact the proposed diversion,out of its natural watershed will have on the watershed. It is a collage of carefully chosen words all playing down or minimizing the impact on the environment, of inter-basin diversion. Because the potential of the Millers River Basin as a water supply source was recognized in the 1920s does not necessarily mean that the solution is a competent one or the sole answer to the water supply problem.

The statement that the socio-economic impact on the donor area is to be positive is highly questionable, and a direct contradiction of the fact that there can be no guarantee made on the quality of the water at the time of diversion either in the basin itself or in Quabbin Reservoir. It is also a well known fact that labor forces for the project would consist of out-of- town help.

If large socio-economic impacts are to be felt by towns supplied by the Quabbin-Sudbury system in a "no go " situation the fault lies solely in the hands of the Metropolitan District Commission for their failure to actively and consistently urge conservation in domestic and industrial usage.

I refer now to page 150 and the summation . People are aware. People are concerned and the average consumer is willing to curtail his consumption of water . We have been and continue to a sk for a voluntary curtailment. The M.D.C. has no basis to condemn an a pproach they have not even tried. 1960 is not 1972 or 1975.

Page 26 again refers, in depth, to the Priest Brook alternative. This has been repeatedly denied as an alternative by the Corps , yet it is still, in fact, a viable consideration. This alternative is definitely damaging to the great natural beauty of the area and by it inclusion throws considerable doubt on the credibility of the entire preliminary draft environmental statement.

Silting is obvious on Royalston Road north from a recent construction project on the Priest Brook. Yet the Corps concludes that silting is minimal. This area has a fine sand content which is very high and the lack of a current survey on silting agains casts doubts on the credibility of this statement.

The East Branch Tully River again is a classic example of the lack of consideration given to the natural environment by the Corps of Engineers. The eight miles of wetland definitely bound to be affected by a loss of water necessary to the riverine cycle. (p.51) Wetlands are wet all year round due to the water derived from that watershed. So where is the data that you base no impact from diversion on here?

Short term solution is amplified for the period 1989-2000 on pgs. 59 & 60. The statement " we envision probable changes"... shows the type of guesswork encompassed in this statement. Page 63 has a chart which diagrams the 8 yr. period that Millers can competently handle the demand. $ 38 million for an eight year solution is foolish. Would it not be wiser to put that amount into research of desalinasion and into recycling water to industries for cooling machineryand to homes for sanitary flushing?

Again we call attention to the inclusion of Priest and Tarbell Brook.(p.66)

48 How is it that no odor was detected at Millers River? (pg. 76) Also ,what data backs up the statement on low significance of impact on page 79? Too many general assumptions [illegible] statements. We demand that these assump-

tions are supported by facts not wishful thinking.

"Long term impacts should be minimal" is a rash assumption and a direct contradiction the statement that long term 20 year projection is definitely tward a lower water quality from the impoundment areas.

On page 83- The construction phase of diversion is a definite ingredient on environmental impact. The validity of an impact statement not including it is questionable.

I call attention to paragraph # 2 on page. 99 that states that the spring freshet is an important factor in shaping the river and that major alterations of the flow , such as diversions, beyond the presently postulated limits will be reflected in changes in the morphology of the river. This has been a principle objection from thd start. You, the Corps, can give no guarantee diversion below the presently postulated limits will not also definitely affect the watershed.

Page 103 gives a chloride table dated 1935-1937, which is insidious by its inclusion. More current data must be furnished to give a more credible statement on impact.

Page 106! I could write a better soap opera. The estimate loss of 600 classrooms is sheer hysteria, and stupidity. If each of the categories listed were to implement con-conservation practices the savings alone in a no go situation would be beneficial. If industrial, and commercial categories employed recycling to cool machinery the drain on Quabbin would have to be cut in some manner.

Also, when you speak of concrete losses what of the taxpayer who has to watch $ 38 million be spent on the purchase of time by seemingly intelligent engineers instead of those same engineers investigating more progressive solutions. If citizens watch their lawns dry up suggesting that their hidden hostilities will suddenly become rampant is solutely ridiculous. A little Yankee ingenuity in your part would go a lot further.

Those impacts felt by supplier area peoples are not tangible. They are the definite destruction of beautiful wooded and scenic areas.

Fellows. This most "adamant" opponent of inter-basin diversion is amazed at your simple minds.(p.109) Moral outrage is not our gripe. The need to more progressively meet water demands is staring you in the face and you can't open your minds long enough to realize it. The definite environmental damage that is so callously played down in this book should not have to happen.

We are not outraged at " being forced to give up our water". Rather we condemn the concept of inter-basin diversion which removes water from its natural watershed and does not return it. Where is the insurance of a healthier Millers and a better aesthetic environment at Priest Brook?

If diversion would insure a cleaner river than otherwise possible under the present implementaion schedule it is only because politicians are playing games. Why have businesses known to be polluters been given repreives time and again for installing the necessary equipment?

Page 110. There is no basis for the astoundingly ridiculous statement that there will be no appreciable impact on the Millers River watershed.

7 Page 113. Note in final statement please that the current high record rainfall has continued into 1973. This has to be taken into consideration.

Page 114. Again I suggest you are stretching your own frustrations into the statement in Paragraph # 3. Instead of suggesting hidden hostilities why not include the National Wildlife Federation survey(1972) that shows people are willing to conserve? And also curtail their own luxury living to help preserve the environment.

8 The analysis of desalination is fair but you continually deny the expense of diverting [illegible] the environment and still leave

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ou with a water supply problem in the years 1989-2000.

S  d the money ~~refining~~ refining tho the more progressive alternatives.

xtra- regional sources is foolish as it is environmentally detrimental to tha basin donor.

aste water re-use-- No one has suggested direct consumption of drinking water that hasb een recycled. Instead we have urged the Corps of Engineers, the M.D.C. and the overnment to demand that recycled water be used in industrial cooling, irrigation, and s a definite source of water for sanitary flushes. Dragging thalidomide into the icture again suggests hysteria on youn part. Do you all drink out of the toilet bowl?

I would like to see the preliminary draft environmental statement change into an onest forthright believable assessment of the environmental impact of the proposed nter-basin diversion. As it now stands, it is a sad portrayal of the quality of ntelligence put forth by the Corps.

Celeste M. McQuillan

Celeste M. McQuillan, secretary of S.O.S.

P.S. I would like to be sent a copy of the draft environmental statement and the final environmental statement.

South Main Street
New Salem, Mass. 01355

December 28, 1972

Department of the Army
N.E. Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

RE: NEDED-R

Gentlemen:

It is clear from the preliminary draft of the environmental statement on the Northfield Mountain and Millers River Basin diversions to the Quabbin that the Connecticut River Diversion through Northfield should proceed. The dangers and possible damages are low relative to Quabbin damage if the water level in the reservoir continues to decrease.

But the Millers and Tully proposals seem to me much more questionable in total environmental impact. With my present confused understanding of the donor area result I cannot enthusiastically vote for the project even though my concern for the Quabbin prods me to do so.

I am disturbed by the easy acceptance of public disapproval of water use restrictions as ". . . found in newspaper clippings during the recent sixties' drought," as meaning that restriction does not offer a viable alternative. It seems to me essential that this study point out emphatically that control of use of this high quality water should be started soon. Education of the MDC system users should proceed rapidly so we will not be faced with the same problem a generation from now when the donor region supplies are gone. MDC should stop being just a salesman for water and start selling conservation of supply.

Very truly yours,

C Russell Shaw

C. Russell Shaw

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In reply to the "Preliminary Draft Environmental Statement" prepared by U.S. Army Engineer Division, New England, Waltham, Mass. of November 1972.

It staggers the imagination of the average private citizen with limited means and without proper research staff or training, such as myself with the prospect of taking up the task of challenging a well staffed and funded project such as this report of 158 pages and some odd maps and plans represent. Take up the challenge I must, for I am the principle landowner in the Priest Brook project area. Although you failed to mention on page 35 that there is also a Tree Farm project containing more acreage than the combined holdings of the trailer park and rod and gun clubs. And I might add, a place where one can already hunt, fish, hike, nature study and pick berries without a chain link fence or gate or special pass to acquire at the sufferance of some indifferent state or federal employee. So, you can hardly claim that your stewardship can add this as you do on page 52.

In the first place, I fail to see how the combined waters of the Tarbell and Priest Brooks could possibly solve the water problems of the M.D.C. Two very scenic and still wild brooks are to be sacrificed for what certainly must be the ultimate in "Rube Goldberg" engineering. Is the effort and cost and certain distruction of important reaches of two still wild brooks with the little water you may acquire in "skimming the flood"?? Can you really expect anyone to believe the last paragraph on page 157 ((Structure can be removed and the land restored to its former condition!?)) The deposits of sphagnum moss and fine grained sands and silt that have accumlated in the Priest Brook project area which you propose to "Strip clean" have taken time that can only be measured against the geological calendar of events to put in place. And you think that if the project doesn't work that you can restore the land so stripped to its former condition? You may sell that idea to some person that doesn't think or reason, but try doing it to one that does.

On the question of land ownership, it will be found on page 55, third paragraph, "Nearly all riparian rights along the reaches of Tarbell and Priest Brooks affected by the proposed diversion are controlled by the Corps of Engineers Birch Hill Dam." One wonders what the Corps of Engineers interpolation of the words, "Nearly all" mean? If it was calculated to impress some future reviewer of your study that little private property will be taken, then I must take exception for it is grossly in error. The riparian rights controlled by the Birch Hill flood control project located



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down stream from the Priest and Tarbell Brooks project sites depends on the elevation of the spillway which is 852 ft. above MSL. In the case of the Tarbell Brook project which it so happens requires the least land you are entirely correct in that it is entirely controlled by the Birch Hill Project. On the Priest Brook project where the greatest amount of land taking is to occur in the entire Tully Complex, the location of your dam at elevation 855 feet above MSL is slightly out of the Birch Hill Flood control area. It would be charitable to say you had reparian rights to five acres. If the elevation of the spillway at Priest Brook Dam is to be the controlling factor in land taking (875 feet above MSL) or the elevation of the top of (890 feet above MSL) than it is in my opinion necessary to condemn at least 1000 acres. The final figure naturally will be considerably more since many tracts of land will be left without access and will be of little use to their present owners. I was told at one of the hearings in Waltham by one of your project study group that "We take back 300 feet from the highest of the high waters." So that if you add this protective belt of 300 feet around a 400 acre "pool" you add up the acreage very substantually. So it will be seen that the words "Nearly all" are construed by this writer to be a means by you to deceive the unwary reader.

The statement on page 157 "No known endangered species of birds or animals utilize the proposed project lands. The amount of nesting habitat for migratory species will remain essentially the same in the region as it is at present." In the Priest Brook project site, the area I know best, I find this just a little hard to believe when we examine the facts. Reasoning tells me that if you remove the vegetative cover from the surface area of the wet lands to the extent of 400 acres, that it will considerably diminish the available nesting sites for that species that now seasonally inhabit the area, but what is even worse is that the natural breeding sites of the insects in the low wet land are the natural feed for a whole host of birds that inhabit the nearby area. Not having specific knowledge of the subject I asked an old acquaintance that does have some little knowledge of the subject. This acquaintance and his wife have banded over 43 thousand birds since 1957 and has served on a joint study project with Canada on migratory birds that has been published a number of times. He has a graduate degree and has spent his life in the academic world. Although he has not lived locally for a number of years, no man has a greater first hand knowledge of the Tarbell Brook area than he. Now over eighty years of age, he was born on the old family homestead on the banks of the same brook. His family settled there a few years after the revolution. When asked if any particular species of bird would be endangered in the area, his prompt reply was, "I don't know of any species that isn't in danger including man himself." Certainally I know the same as you that the "passenger pigeon" is forever gone and that nothing quite so exotic as the "whooping crane" nests in the area, but I do know, the same as you should, that if you keep removing natural nesting and feeding areas that the laws of diminishing returns must eventually be invoked against us all. Even in my short life span, I've seen the once numerous "blue bird" become a very rare sight. I wonder what background your authority had to make his statement from? And how long was his stay in the area in question? Or is it the result of another computer "impute" to use a term that your staff always seemed to refer to whenever confronted with a question at your public hearings.

To fully understand how you arrived at the figures of possible economic losses to the receiver comunities and the estimates of losses of "say 600 classrooms," or that the water sprinkling industry is something even to be considered (page 100). One has only to read your contract awarded to the ABT Associates, Inc., for the "Socio-Economic Impact Studies," and what information they are expected to bring back to earn their carrot. Under section 3, Contract Services, subpact "E", "for alternative go" "no go" scenarios. The scenarios to be considered are: etc. & etc."

In other words bring us back a comic opera. For example, "frustrated as they see their lawns dry up during watering bans," (page 107 & 115.) Or the Socio-economic Impact Measurement table - with its 20 "Impact Categories" and suggested measures. Anyone of these 20 "Impact Categories" listed can only be answered by "extrapolation." Never forget for one moment that in the rules of evidence, that a guess whether it is learned or otherwise is as good as useless and at best can only be used as a clue. The burden of proof still remains upon you and no amount of manouvering will relieve you of that duty. I for one would like to believe that I came from a nation of people that wouldn't become frustrated just because they couldn't water their lawns, and I would hope that you would entertain the same belief also. For if it is not so and our people are so morally bankrupt as that, then in my opinion all is lost.

On page 155 under the title of "Population Zoning and Regulations" we find the rather interesting quote, "A question of constitutionality to the principle of popluation zoning." Most of the cities and towns of the Commonwealth already have zoning laws. Granted that for the most part they are merely building codes, but in effect are they not really population zoning in mild form? If one cannot build a house or factory in a certain area, couldn't it be considered as a means of limiting growth? I don't have the means at this isolated homestead to ascertain if the Constitutionality of the existing zoning laws have been tested in court. I can only assume that if they had a ruling against them, that they would no longer be in effect and that since they still remain on the books then it is a logical assumption that they are not depriving anyone of their Constitutional Rights. As for Constitutional Rights in real property, the tenure system is not spelled out in a single basic document. It depends heavily upon the common law and court decisions, rather than concise statutory enactments. It evolved slowly before and during the colonial period. Most of the breaks with the mother country's tenure system were formalized in statutory enactments or were developed in practice by the time of the Constitution. For this reason it would appear that Constitutional questions do not arise out of zoning legislation which has to do with land use. I would assume that if a question of Constitutional Right does exist to the "principle of population zoning," then certainally I should have the same protection against the politically powerful in the urban centers from exercising the States right of "eminent domain" upon me to deprive me of my right in property. Whatever the answer to this question is to be, you can be sure that before your proposed project on the Priest Brook is started, the courts will have to decide. For I can assure you that there is no other way.

I've been told that I don't stand a chance in answering the challenge. Especially in view of the original Quabbin Reservoir Project when 4 towns were taken with 83,500 acres and more than 2,500 people living in 650 homes were required to leave. Not even the ancient burial yards containing 7,561 bodies were spared. However, since April 26, 1927 when a special Act of the Mass. Legislature, created the Metropolitan Water Supply Commission a new awareness has come to pass in the last few years that we must put a limit upon the indiscriminate use of our land and natural resources or we shall all be destroyed. You may find it hard going to get a judgement against me.

The question of alternatives to the present proposed plans for implementing the diminishing water supplies in Quabbin Reservoir has at all the hearings and in the present study in question been thrust before us as if it were our duty to solve the problems of your alleged dilemma. I cannot see where any such burden can rightfully be placed upon us in the donor area. What you have been saying is, "Jean, I'm going to burn your house down, What alternative will you give us?"

Through the so-called miracle of modern engineering this Commonwealth's greatest metropolitan center has been completely encircled with a vast asphalt desert. Any water that might percolate down to the water table for many miles around has been very effectively channeled off through paved ditches and storm drains so that it will quickly run off into the sea. Hundreds of thousands of once valuable acres have been paved over for parking lots, freeways, access roads, etc. Did it ever occur to anyone that your problems are self inflicted? Did it ever occur to anyone that no generation since the founding of our country has been without war, and through the miracle of modern engineering that your greatest metropolitan centers have been made so vulnerable that less than a weeks' siege by modern warfare would be their ruin? I don't even dare to think of what could happen to the water supply, least I be accused of plotting against it.

But there it is all before me, and the danger seems so self evident to me, a common lay-man, that your safty perhaps rests in the fact that no professional military planner would believe it to be true. Are you to continue on the same dangerous course? Is it not time to have the moral courage to say "No" to somebody?

Jean A. Simoneau

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55 Union St.
Gardner, Mass.
25 December 1972

Mr. John WM. Leslie, Chief, Engineering Division
Department Of The Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

I am pleased to forward to you the following views regarding the Preliminary Draft Environmental Statement on Northfield Mountain Water Supply Project-Miller's River Basin Water Supply Project, dated November 1972.

At the outset let me state that I firmly believe a depleted Quabbin Reservoir would constitute a catastrophe of the highest magnitude. Further, it is my opinion that any projects or manipulations to alleviate such a situation should be held to main stem where absolutely possible or close to main stem where absolutely necessary. In my estimation the impacts related to Alternate # 3 of the Miller's River Basin Project make that offering unworthy of consideration.

My criticism is hopefully constructive, and in no way is meant to degrade a relatively well written draft.

On page 19, under Alternative No. 2 - Tully-Millers Diversion, first paragraph, penultimate sentence states, "As in alternate No. 1, waste treatment plants on six point sources of pollution would also be required". Yet on Page 16, under Alternate No. 1, middle of page, a sentence reads, "Based on our evaluation, it appeared that the river, even after proposed secondary treatment "clean up," might require additional or advanced waste treatment at the point sources of pollution. It is understood that waste treatment plants on six point sources of pollution on the Millers have already been guaranteed by Mass. Div. of Water Pollution Control by 1976, whether any diversion is Go or No Go. Perhaps the previous mentioned sentence on Page 19 should read: "As in Alternate No. 1, advanced waste treatment plants ---- would also be required".

On page 21, regarding Miller's River, last sentence reads. "But, neither would the flow be augmented when it was naturally below the control flow". Since the same procedure would apply for diversion of East Branch Tully River, and release of flood control water enters in, the exact position of flow monitoring stations must be spelled out.

During deliberations at CRC on the Conn. River Plan, a 17,000 cfs figure was used in conjunction with hydro-electric studies and flow releases from power dams. Is this figure appropriate for diversions? I mention this because releases from power dams might affect the flow regimen of the Conn. River main stem, and this in turn might have an unnatural effect on the diversion from tributaries.

On page 25, under Alternate No. 2, second paragraph states, "But also provides flood control protection on the East Branch Tully River." Page 24 says, "Flood control protection attributable to this alternative are minimal." Also on page 25, second paragraph, is found: "Some 30 miles of streams would become excellent quality ----." This comes under general discussion of Tully. Streams in the Tully area are already excellent as witnessed by Tully Reservoir Diversion under Environmental Setting Without The Project, last paragraph P. 35.

On page 49, Miller's River Alternatives - Environmental Impact Of The Proposed Action, a key sentence is this: "Considering future water inputs to Quabbin Reservoir it must be borne in mind that Alternate No. 1 or No. 2 would not be implemented until water quality of the Millers River meets all public health as well as environmental standards present at Quabbin." If this be true, and the statement is not taken out of context - also considering previous statements likewise, it would seem that the greatest loss to Quabbin from Alternative No. 1 might simply be 8 MGD. The difference between Millers 68MGD and Millers-Tully 76MGD.

Phase II of the proposed diversions represents a period 1976-1980. This constitutes Conn. R. diversion only. A peak at Quabbin is reached in '84. Bear in mind a "cleaned up" Millers River (secondary treatment) has been guaranteed by Mass. Div. of Water Pollution Control for '76. Considering next that a ten foot tunnel from main stem Millers to Quabbin with its inlet and outlet structures are necessary under either Alternative No. 1 or No. 2, and might be constructed in initial stages of either alternative; it would seem (to a layman) that a satisfactory time frame for an evaluation of the so called "cleaned-up". Millers might be available, leaving the Tully-Millers Alternative appreciably engineered, constructed, and standing by. - USING ALTERNATIVE NO. I AS A GO.
Certainly the concept of stage development as a tool by water resource specialists is clearly understood; however

every possible understandable effort must be made to preserve and safeguard free flowing tributary streams that future generations might have an option. This especially considering possible future technological break throughs. The fish and wildlife as well as aesthetic values and their associated socio-economic impact alone is appreciable.

I thoroughly understand the necessity for a relatively full Quabbin with quality water, and have written several sporting articles relative to that resource. The opportunity for sharing these views is appreciated.

Sincerely,

Warren M. Sinclair

The Commonwealth of Massachusetts
Holyoke Community College
291 Pine Street
Holyoke 01040

TELEPHONE: 536-1624

December 21, 1972

Mr. John Wm. Leslie, Chief
Engineering Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

This letter is in reply to your "Preliminary Draft Environmental Statement for the Northfield Mountain and Miller's River Basin Diversio Proposal for the Northeast Water Supply Study". I wish to express my thanks to you for giving me this opportunity to comment on the Environmental Impact Statement (E.I.S.).

My discussion of the E.I.S. is separated into two sections: A) Presumed Typographical Errors, and B) Differences between my philosophy and that of the Corps of Engineers and the Metropolitan Distric Commission with respect to providing water for increasing human demands.

A) Presumed Typographical Errors:

1) Beginning on Page 21 and thereafter of the E.I.S., several abbreviations are used for which no definitions are given. These abbreviations include CSM, MBAS, $\Delta QR = \Delta QL$, and CCE. In my opinion, the final statement should define these abbreviations.

2) Beginning on page 41, and thereafter, citations are made from several publications, but no bibliographical sources are included at th end of the E.I.S.. This should be rectified.

3) On page 73 (line 12) you state, "A comparison of study data wit other available data suggests COD values for the Connecticut River are about two times as high as for the Quabbin 'inside' station..." In Volume II of "Water Quality Studies, Connecticut and Miller's River Systems and Quabbin and Wachusett Resevoirs, Massachusetts" (New Englan Research, Inc., Nov. 1971), the statement is made on page 60, line20, that "The COD values of Quabbin 'inside station' are not much different from those of the Connecticut River". This discrepancy should be dealt with in the final E.I.S..

4) On page 88 of the E.I.S. (line 20) the statement is made that "Since the temperature and salinity rises are so small ($72^{\circ}$F. and a few Mg/L) at any given point...". On page 13 (line 10) of "Possible Effects of Various Diversions from the Connecticut River" (Essex Marine Laboratory Report #2, May 1972), the statement is made, "Since the temperature and salinity rises are so small ($\leq 2^{\circ}$F. and a few mg/l) at any given point...". The final E.I.S. should deal with this discrep

5) Since you quote so liberally from New England Research, Inc. and from Essex Marine Laboratory reports, I think it only fair to the scientific community which will be examining the E.I.S. critically that full reference to those reports, as well as to any other reports contracted by the Corps, be made in the final E.I.S. and that these reports be readily available to interested parties.

6) In your conclusions as to why a groundwater alternative is not in the best interests of the state as a whole (page 131) you fail to mention exactly how much more costly ground water would be. The final E.I.S. should do so, in my opinion, and should also relate this cost (as well as other alternative costs) to the fact that the MDC will not be paying the western end of the state for water skimmed from the Connecticut and Miller's Rivers. The lack of payment for water to be "skimmed" from the western watershed obviously makes a much more attractive alternative.

B) Philosophical Differences

Generally speaking, I was distressed to see that in the 158 page E.I.S. that although you did devote 22 pages to an examination of the the estuary and its relationship to the proposed diversions, only five pages were devoted to the immediate donor areas (i.e., the Connecticut River at Northfield and various diversion schemes from the Miller's River System). It will not be my intent here to give an overall philosophical discussion of why this diversion plan should be abandoned (see Connecticut River Ecology Action Corporation and Connecticut River Watershed Council replies for this) but rather to concentrate my remarks on specific points.

1) Flood skimming at 17,000 vs. 12,000 cubic feet per second (cfs); On page 10 you atate that 17,000cfs is the limit at the Montague gauging station below which no water will be taken from the Connecticut River System (this critical flow specified in current Massachusetts legislation). Yet you do not cite any scientific rationale of an environmental nature for the 17,000cfs figure and frequently elsewhere (pages 84,89,93,99,104, and 105) cite evidence as to the lack of expected damage if 12,000cfs were set as the low figure at the Montague gauging station. Not only is one left with the impression that the eastern end of the state will come back for more water once Quabbin again begins to run dry (your figure 1, page 63 strongly suggests this), but one becomes extremely concerned in light of the Essex Marine Laboratory report statement on page 14, and 15:

"1. Until considerably more work is done to fully delineate the physical and biological parameters of the river, the controlling flow for diversion should be considered at no less then 17,000cfs at Montague City.

2. Research in connection with the preparation of this report revealed the extreme paucity of relevant data, both physical and biological. Rational decisions involving alterations of the natural regimen of the river are difficult in the absence of such data. A program should be undertaken without delay to provide the information which will be required as future demands arise for new uses of the river.

3. Specifically, in the biological field the following

are among the most pressing needs.

a. The biology of the lower river at and below the fresh-water-saltwater interface is little known. A complete biological inventory is essential if the possibility exists of future alterations which would affect this area.

b. While some work is presently underway, there is much to be learned about the homing mechanism of the shad, and the effects of temperature or of flow volume and velocity on its spawning migration. The same parameters may well effect the population dynamics of other fish and lower species in the food chain.

c. If the current attempt to restore the Atlantic Salmon to the Connecticut River is successful, the requirements of this important species must be intensively studied to safeguard its continuing existence.

4. A three part program for delineating the physical and chemical characteristics of the river is required to provide information needed not only for future decisions, but to assess the effects of alterations presently in the planning stage.

a. A continuous in situ monitoring system should be established to measure such common parameters as temperature, dissolved oxygen, conductivity, and flow velocity. The technology for such a system is readily available, and considerably less expensive than it was even a few years ago.

b. An hydraulic model of the river should be constructed, using the data from the monitoring system for calibration.

c. Data from the monitoring system and the hydraulic model would make possible the design and calibration of a mathematical model. Such a model would make it possible to test the effects of proposed changes in river utilization at a very reasonable cost. Attempts to mathematically model the river in the absence of real physical and chemical data have not been satisfactory."

2) Lack of concrete information that diversion will not have a detrimental effect on the donor and recipient areas. In several places (see page 37, line 1; p.42, l. 3; p.72, l.7; p.75, l. 22; and page 82, line 22 for some specific details) the E.I.S. is is unabl to predict with any certainty the effects that the proposed diversions will have on the physical, chemical and biological balances and quality of drinking water of either the donor or recipient watersheds.

3. Lack of sound data on the affect of diversion on donor ground water supplies. On page 110, line 22, the E.I.S. states that "...no appreciable impact on the hydrology of the Miller's River watershed is expected." This statement is misleading in light of Berger's paper ("Environmental Aspects of River Diversion" in Forste, R. H. 1971. "Proceedings of the New England Conference on River Diversions" Water Resources Research Center, Univ. of New Hampshire, Durham. 162pp.) which states (page 29-30) concerning diversions from the Connecticut River in general:

"A diversion of 72 mgd, the proposed average diversion on an annual basis at Northfield, would lower the stage by 0.2 feet at this location and by lesser amounts downstream. It is conjectured that this would not significantly affect the total quantity of groundwater in the Connecticut River Basin (Farquhar, in press). The important question is what magnitude of diversion would produce measurable reduction in Connecticut River Basin aquifers? It is not possible to answer this question at this time."

Further reading of Berger's paper made me extremely skeptical with respect to further diversions from the Connecticut River and/or its tributaries.

4) Lack of information as to the environmental impact of construction and annual cleanup of spoils: On page 52 (line 25)and on page 108(line 3) you mention the need for stripping organic matter from Tully Lake and the need for disposal sites for the spoils created by tunnelling to Quabbin. Admitedly, the latter problem would develop only once, but the former could be an annual one. The draft E.I.S. however does not deal adequately with either of these problems.

5) Desalination as an alternative:

a) costs of desalinated water: On page 122 (line 18) you state that desalinated water "indicate costs in the vicinity of 73 cents per thousand gallons." This seems to me to be misleading, in light of the enclosed cost graph reproduced from the "North Atlantic Regional Water Resources Study (1972) Appendix R--Water Supply; Corps of Engineers, U. S. Army: p. 176.

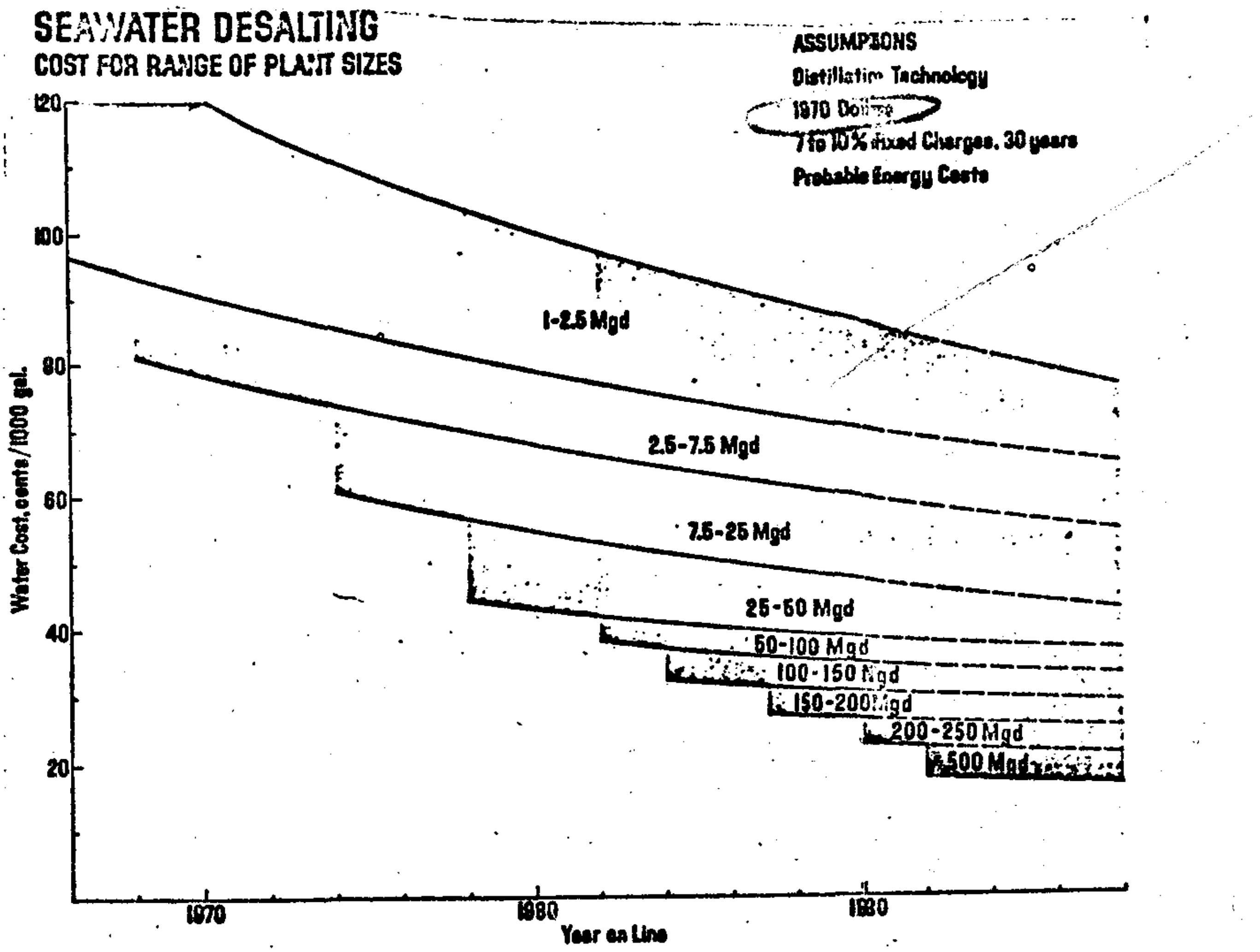


FIGURE R-35. SEAWATER DESALTING - COST FOR RANGE OF PLANT SIZES

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Desalting sea water may, indeed , cost $0.73 per thousand gallons now, but before you estimate Quabbin will dry under a "do nothing alternative" the cost of desalinated water will be less than one-half of the figure you cite in the E.I.S..

b) Desalination as an alternative--It is apparent to me that the proposed diversions are no more than stop-gap measures (see page 63 and fold out sheet entitled "Estimated Demand on Quabbin-Wachusett System for verification of this observation). What is needed now is a bold new approach. As the North Atlantic Regional Water Resources Study, Appendix R, p. 157 has so aptly pointed out:

> "A significant aspect of desalting is its capability to provide a completely controllable new source of fresh water that isn't subject to the whims of nature. Furthermore, it is a source not complicated by many of the institutional constraints that often exist with inter-basin transfers or with local diversion. Its flexibility permits it to be located near the area of need, with units added as the demand increases. This permits it to be used as a firm supply, as an interim supply until large surface water systems can be put into operation, and as a conjuctive supply to increase the firm yield of an existing system."

With these words in mind as a possibility for solving the proble of the water-poor eastern end of the state, I completed the following documented research paper for the Massachusetts Executive Office of Environmental Affairs, in my capacity as a member of the Water Resour Task Force, appointed by Secretary Charles H.W. Foster.

## Report to the Water Resource Task Force: 1972--Desalination

### Introduction

Rubey (1951) has stated that of the juvenile outgasings from the earth, only 1.0% of this vapor is sufficient to replenish our geological water supplies. The problem of water then is not one of amour but of availability at the right place and right time. Due to geological techtonics, most of this juvenile water is being made availabl to our hydrosphere at mid-oceanic trenches and tabular data presentec by Popkin (1964:4) indicate that 97.2% (or 317,000,000 cubic miles) c our available water is to be found in the oceans. Therefore, it seem most appropriate that one look to the oceans and (if economically feasible) accelerate the water cycle to replenish dwindling fresh wat supplies. Popkin (1969) enthusiasticly reviews the present state of the are and economics of desalination and also presents abundant data to refute a contention made by Hirshleifer, at al. (1960) for the RAND Corporation that desalination is not economically or technically feasible. Odum (1971), in a much briefer, but perhaps more thoughtfu review of the problems associated with desalination cautions against over use of this means of solving all of man's water problems without prior ecological and social studies of the environment, but even he states (p. 419): "There is very little hazard in desalting of ocean water for use as drinking water in densely populated coastal urban areas..." The purpose of this report, then, will be to review desalination (and the problems associated with it) as a means of replenishing Massachusetts fresh-water supplies.

### Other Meand than Desalination

Before proceeding with a discussion of the benefit/cost analysis of desalination, it seems appropriate to review briefly the other con templated sources of fresh water for Massachusetts' needs.

a) Surface water--One need not proceed far in the literature before realizing that this resource is being depleted at an alarming rate. Popkin (1969) estimates that on a global scale 0.01% (30,300 cubic miles) of the earth's hydrosphere is constituted as fresh water lakes, rivers, and streams, and with respect to our region's water supplies, the U. S. Geological Survey (Piper, 1965)--for New England in general--and the Army Corps of Engineers (NEWS, 1972)--for the state; specifically Quabbin Resevoir--estimate that before the year 2000, water may be in critical supply in this state if present consumptive patterns continue; the U.S.G.S. report, however, states that with wise use the supply problem may not be as great a crisis as the Corps contemplates.

b) Plans are rapidly reaching the implementation stage for the out-of-basin diversion of water from rich areas (eg., Western Massachusetts) to water poor areas (eg., Boston). However, as Kendeigh (1961), Keighton (1965), Benton & Werner (1966), Smith (1966), Odum (1971), Brower (1972), Chapman (1972), and EMLR (1972) collectively show, on both theoretical and practical grounds, of the importance to estuaries, of the flooding cycle, the plans for river diversions (in the absence of base-line data on the biology of specific estuaries) are unwarranted. Not only are diversions potentially damaging to the estuaries--the richest energy and food source in the world (Douglas and Stroud, 1971; NES, 1970; and NAR, 1971)--of the rivers from which these diversions take place, but also for in-basin citizens, out-of-basin diversions remove a resource (eg., potentially potable water) that they would find most difficult to re-obtain at a later date when these citizens require their own river waters for their own use.

c) Soil and Ground Water. This report does not deal with the feasibility of harvesting this resource, but as a result of surveying the tabular data presented by Popkin (1969:4) which indicate that only 0.62% (2,016,000 cubic miles) of the earth's hydrosphere is in this form of water, it seems, that as a long-term source of water, pursuit of this potential supply has world-wide limitations. Only a detailed study of Massachusetts sub-surface supplies will indicate to what extent these limitations apply in this state.

## Desalination

As indicated earlier, this report was to deal with a discussion of the benefit/cost ratio analysis of desalination. It should be pointed out, however, before beginning that this discussion will be brief, as there is abundant literature already, on all phases of desalination (eg., see Johnson, 1970; and OSW, 1972, for abstracts of approximately 2000 technical papers and reports dealing with not only the state of the art of desalination, but also its social economic and ecological environmental benefits, and costs as well).

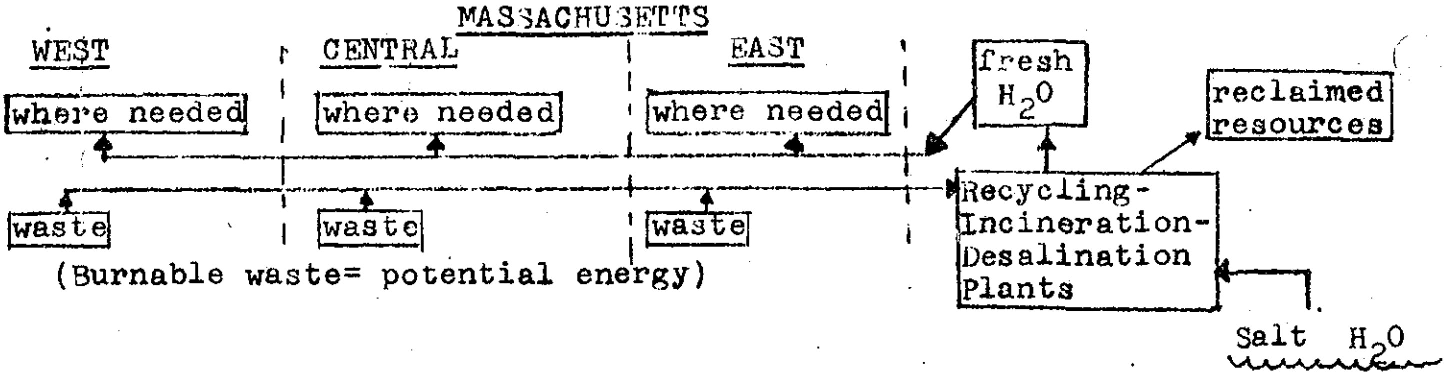
## Benefits

At this stage in the history of Massachusetts' utilization of its water resources, there is a two-fold problem which at first glance doesn't appear to be related. The aspects of this problem are: supplies and distribution of potable water and disposal of solid wastes.

With respect to the first problem, growth of urban areas in the eastern part of the state long ago stripped their long-term reserves of fresh water which ultimately resulted in the construction of Quabbin Resevoir which was felt at its inception to be the final answer. Yet, as is now well known, this is not the case. NEWS (1972) estimates that already the existing system yield of Quabbin is being exceeded by the demand placed on this resevoir. Admitedly, a better conservation program would alleviate the problem (Piper, 1965), but based on the history of human nature, wants or desires very quickly become needs which generate demands which can't very quickly be eliminated by convincing people that these so-called needs are unnecessary in the pursuit of the "good life". So, although an enlightened education of the public is essential in order to develop their continuing concern for a natural resource usually taken for granted (i.e., water), nevertheless, a program of accelerating the supply of this resource in a way least dama to the environment is necessary. Desalination of sea water provides such a means, because (1) it fits fore naturally into the geological water cycle than do other means of supplying potable water (eg., diversions from one river basin to another), (2)it provides for the control of fresh water supplies closest to the major and ultimate source of these fresh water supplies (i.e., the sea) and (3) desalination techniques fit more easily into the application of the law of supply and demand than do other techniques for supplying fresh water, in that under temporary high demand needs, more output can be sought to augment natural fresh water supplies, while when the demand is low, less salt water need desalinated. How the latter would be regulated would depend a great deal upon the economics of desalting larger vs. smaller amounts of salt water (see Spiewak and Ebel, 1967). Also, with saline technology proceeding so rapidly, it is evident that de-salting facilities can be constructed in an open space much smaller than a fresh water resevoir, and yet, in the long run, is likely to produce water at a far cheaper environmental cost and in larger amounts.

With respect to the energy necessary to desalinate sea water, a problem would appear to be in the offing--the well-documented energy crisis that this country is facing. Although many authors enthusiastically support nuclear energy as a source for desalination (see Johnson, 1970 for many references on this matter), nevertheless, there are questions in many reputable scientists' minds--including sever Nobel Laureates with expertise in the field of nuclear energy (eg., Joshua Lederberg)--that this technology has not reached the stage of development where it can be depended upon to produce safe supplies of inexpensive energy. Yet, solid waste as a source of energy has been examined by many authorities (eg., Reichle, 1965; and Gitterman and Zgickler, 1966) and according to recent press releases, states are committing themselves to this "resource" (eg., Northeast Utilities, General Electric, Southern Connecticut Gas Co., the State of Connecticut and the federal government have committed 1.2 million dollars to a solid waste disposal-energy generating project). Also, the town of Saugus, Massachusetts is planning an energy conversion plant capable of transforming the refuse of 16 communities including Boston and Lynn into commercially salable steam (FN, 1972:12). Massachusetts, with its solid waste disposal problem, rapidly filling sanitary land-fill sites, and increased expenses that other communities--eg., Westchester Co., N.Y. (Greenhouse, 1972)--are experiencing, using this technique of dealing with solid waste, can ill afford not to seek other, more environmentally sound, expeditious, economical, and efficient means of dealing with solid wastes.

Stickel (1972) has presented a proposal for combining desalination (as a means of solving fresh water supply problems) and the energy that can be generated from solid waste (as a means of eliminating that problem).* This proposal is presented pictorially below:




Admittedly, the above is a bold step and a complete turn-around with respect to the direction that fresh water is now "flowing" (eg., present and proposed diversions of Connecticut River Basin Water) but there are precedents for such a scheme.

1) The well-known water cycle--from the sky; to the ground; to watersheds; to rivers; to the sea; and back to the sky. The above scheme would essentially do the same with the substitution of the recycling--incinerator--desalination plants for the sun as an energy source for moving water from the oceans back into the sky and pipes (substituted for wind currents) for moving water back into natural watersheds. With the critical need for rubbish disposal sites in Massachusetts, an incineration scheme as outlined above would solve this problem in one effort (and would keep Massachusetts' railroads alive too).

2) Such a desalination plant is already in operation at Hempstead, Long Island, New York.

Costs

The overall costs of desalination can be placed into three categories: 1) Plant Construction Costs, 2) Desalination Costs, and Environmental Costs.

1) Plant Construction Costs: It would be premature, at this time, to attempt to place a precise cost on plant construction. This does not mean that this information is not available (pers. comm. from *Frank O'Shaunnesy, Division of Desalting Feasibility & Economic Studies*

* Since the writing of the original paper, a feasibility study involving the use of energy from a refuse incinerator has been brought to this writer's attention. Kaiser Engineers. 1972. "Preliminary Engineering and Cost Assesment: San Diego Refuse Incinerator-Desalting Plant" prepared for the U. S. Dept. of the Interior (Office of Saline Water) and City of San Diego. Rept #72-26-RE. 36pp.; Costs per 1000 gallons of desalinated water =$0.60.

of the Office of Saline Water; ADL, 1972; and BLR and OSW, 1972), but rather a thorough study of plant site selection, energy process to be utilized, and desalting technique to be employed, must first be undertaken for any specific desalination operation. This was not the purpose of this report.

2) Desalination Costs: The costs of desalting sea water have dropped dramatically in the last 20 years. From $5.00 per thousand gallons in the early 1950's, the cost dropped in 1960 to $2.00, and a year later was down to $1.00 per thousand gallons. According to Popkin (1969), a Key West, Florida plant is producing desalinated water at $0.85 per thousand gallons, and the technology is available to place the average costs of desalination at approximately $0.50 per thousand gallons (pers. comm. from J.J. Strobel, Chief, Desalting Feasibility and Economic Studies, OSW). Others (Hammond, 1962 and GNEC, 1964) estimate the costs could readily fall to $0.15 to $0.18 per thousand gallons, depending upon the type of desalination operation.*

3) Environmental Costs: The problem of dealing with brine wastes is a very valid one, and has been intensively studied (Thompson, et al., 1969: Zeitoun, et al., 1969 and Clarke, et al., 1970). Methods are being devised to prevent pollution of estuaries and other off-shore areas by desalination plants (Zeitoun, et al., 1969).** Also, AAPG (1971) and others (eg., Alverson, 1970) have intensively examined the potential for deep-well disposal of saline wastes. As Dr. Travers Hughes of the Geology Department, University of Alabama, Tuscaloosa, Alabama, pointed out in a personal communication, a thorough geological survey of potential disposal sites that are available must be completed before injection of any waste is attempted, but he feels that in the case of brine--a material with a chemical constituency similar to very deep water supplies--such injections would very likely have a self-sealing effect upon the wells utilized for such waste disposal.

## Recommendations

As Johnson (1970:1441) pointed out in his Introduction to the Symposium, Saline Water, a Valuable Resource, "The rapid development of desalination technology has brought with it the recognition of a new intrinsic worth for saline water... and with it...among hydrologists and water resource managers, the recognition that...saline water.. actually could be a valuable resource." To me, it seems important for water resource managers with responsibilities for providing for Massachusetts water supplies to pursue detailed studies now, and to implement desalination techniques as soon as possible for the following reasons:

1) the obvious need for potable water

* According to Frank O'Shaunessy (pers. comm.) of the Office of Saline Water, United States Department of the Interior. The state of the art of desalination is such that $0.30 per thousand gallons is probably the lowest cost one can expect for desalinated water for the foreseeable future.

** Also, OSW has completed model studies which indicate that brine can safely disposed of by diffusion into open oceans. (pers. comm., Frank O'Shaunnesy, Office of Saline Water, Dept. of the Interior.

2) the very real potential damaging effects that the present techniques (i.e., inter-basin water diversions) can have upon the donor rivers' estuaries (see EMLR, 1972 for a report on this matter with specific reference to the Connecticut River).

3) the inflexibility of the present "water taking" techniques, in that ecological constraints are placed on water diversions as to how much can be taken and how large the impoundments can be; desalination has no such ecological limitations.

4) the likelihood that citizens' environmental groups will engage in costly and time-consuming litigation (for the state) pursuant to the National Environmental Policy Act, the Massachusetts Citizens Right to Sue Law, and the newly-passed Massachusetts Environmental Policy Act, if river diversions from the western end of the state are utilized as a solution to the potable water problems of the eastern end of the state.

Literature Cited

AAPG (=American Association of Petroleum Geologists) 1971. Waste Management and Environmental Implications: Symposium Program. Bull. AAPG 55(11)2078-2092.

ADL (=Arthur D. Little, Inc.) 1972. A Planning Model to Project the Potential for Desalting in the United States. A. D. Little, Inc., Report to the Office of Saline Water, Boston; 131pp.

Alverson, R. M. 1970. Deep Well Disposal Study for Baldwin, Escambia, and Mobile Counties, Alabama. Geol. Survey of Alabama Circ. #58 University, Alabama; 49pp.

Benton, A. H. and W. E. Werner 1966. Field Biology and Ecology 2nd ed. McGraw-Hill Book Co., N. Y., N. Y. 499pp.

BLR and OSW (=Bureau of Land Reclaimation and Office of Saline Water) 1972. Desalting Handbook for Planners. U. S. Dept. of Interior, Washinton, D. C. 250pp.

Brower, L. P. 1972. The Flooding River: A Study in Riverine Ecology. 16mm. color-sound film. John Wiley Publ., N. Y., N. Y. 35mins.

Chapman, C. R. 1971. The Texas Water Plan and its Effect on Estuaries in A Symposium on the Biological Significance of Estuaries: 40-57.

Clarke, W. D. et al. 1970. Biological Effects of Effluents from a Desalination Plant at Key West, Florida. Westinghouse Ocean Research Lab. San Diego, Calif. 94pp.

Douglas, P. A. and R. H. Stroud 1971. A Symposium on the Biological Significance of Estuaries. Sport Fishing Institute Washington, D. C. 111pp.

EMLR (=Essex Marine Laboratory) 1972. Possible Effects of Various Diversions from the Connecticut River. Essex Marine Laboratory Report #2. Essex, Connecticut 147pp.

EN (=Environmental NewsLetter) 1972. Proposed Energy Conversion from Refuse in Environmental Newsletter. August Issue. U. S. Environmental Protection Agency, Boston, Mass. 24pp.

Gitterman, H. and S. Zgickler. 1966. Use of Waste Heat for Production of Fresh Water. Burns and Roe, Inc., Oradell, N.J. 77pp.

GNEC (=General Nuclear Engineering Corp.) 1964. Desalination of Water. Power Reactor Technology 7:138-144.

Greenhouse, L. 1972. Dumping Costs Up in Westchester. N. Y. Times June 25, 1972(1):60.

Hammond, R. P. 1962. Large Reactors may Distill Sea Water Economically. Nucleonics 20(12):45-49.

Hirshleifer, J. et al. 1960. Water Supply: Economics, Technology, and Policy. Univ. of Chic. Press. Chic., Ill. 200pp.

Johnson, A. I. 1970. Saline Water Symposium, Introduction in Saline Water, a Valuable Resource. Wash., D. C. 6(5):1441.

Johnson, K. O. 1970. Abstracts of Literature in the Distillation of Sea Water and on the Use of Nuclear Energy for Desalting. Office of Saline Water. Wash., D. C. 279pp.

Keighton, W. B. 1965. Fresh Water Discharge--Salinity Relations in the Tidal Delaware River. Open File Report of the U. S. Geol. Survey. U.S.G.S. Philadelphia, Pa. 17pp.

Kendeigh, S. C. 1961. Animal Ecology. Prentice-Hall, Inc. Englewood Cliffs, N.J. 468pp.

NAR (=North American Regional Water Resource Study) 1971. Coastal Estuarine Areas, Appendix V. North Atlantic Regional Water Resources Study Coordinating Committee, N.Y., N.Y. 295pp.

NES (=National Estuary Study) 1970. U. S. Dept. of Interior, Fish and Wildlife Service. Wash., D. C. 7 volumes.

NEWS (=Northeastern United States Water Supply) 1972. Southeastern New England Study. Corps of Engineers. Waltham, Mass. 90pp.

Odum, E. P. 1971. Fundamentals of Ecology. 3rd ed. W. B. Saunders, Co., Philadelphia, Pa. 574pp.

OSW (=Office of Saline Water) 1971. Saline Water Conversion Report. Office of Saline Water. Wash., D. C. 200pp.

Piper, A. M. 1965. Has the United States Enough Water? U.S.G.S. Water Supply Paper 1797 U.S.G.S. Wash., D.C. 27pp.

Popkin, R. 1969. Desalination: Water for the World's Future. F. A. Praeger, Praeger, Publ., N.Y., N.Y. 235pp.

Reichle, F.L.C. 1967. Evaluation of All Potential Sources of Energy for Desalting. Proc. Intern. Symp. Water Desalination 1965:604-19.

Rubey, W. H. 1951. The Geological History of Sea Waters. Bull. Geol. Soc. Amer. 62:1111-1148.

Smith, R. S. 1966. Ecology and Field Biology. Harper and Row, Publ., N. Y., N. Y. 686pp.

Spievak, I. and R. A. Ebel 1967. Cost Projections for Large Desalting Systems with Various Types of Coupling. Paper P/556 Int. Conf. Water. Peace. Wash., D. C. :8pp.

Stickel, D. W. 1972. Preliminary Report to the Water Resource Task Force--Desalination. unpub. 2pp.

Thompson, D. A. et al. 1969. Environmental Impact of Brine Effluents on Gulf of California. Univ. of Ariz., Tucson, Az. 196pp.

Zeitoun, M. A. et al. 1969. Disposal of the Effluents from Desalination Plants in Estuarine Waters. Dow Chemical Co. Midland, Mich. 140pp.

I am convinced more than ever that diversions should be downgraded as an alternative method of satisfying man's water needs. Desalination may not be the final answer, but it, along with ground water supplies,should be giv8n far more attention in this age of rapid technological advances than inter-basin transfers.

In conclusion, I can say no more than to echo the following observation from the New England Research Incorporated Report (Vol.II, page 15):

> "Research on the environmental impact of projects is not to be used to justify decisions already made, but rather, the decisions are themselves to be influenced by research."

I would appreciate my statement being made part of the final environmental impact statement, and that I receive a copy of the final environmental impact statement.

Yours sincerely,

David W. Stickel

David W. Stickel,
1)Asst. Prof. of Biology,
Holyoke Community College
2)1972 Water Resource Task Force for the Commonwealth of Massachusetts
3)Board of Directors, Connecticut River Ecology Action Corporation

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Titan's Pier
South Hadley, Mass. 01075
27 December 1972.

John W. Leslie, Chief
Engineering Division, Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Mass. 02154

Dear Mr. Leslie:

The following comments on the Preliminary Draft Environmental Statement for the Northfield Mountain Water Supply Project and the Miller's River Basin Water Supply Project - Northeast Water Supply Study (NEWS) represent an extension of earlier statements made on 11 Jan. 1972 and 6 July 1972 on behalf of the Sierra Club, New England Chapter and the Connecticut River Basin Task Force.

The nature of the traditional method of obtaining drinking water for the Metropolitan District Commission's service area has unduly influenced the Corps of Engineers in its study of additional water supplies. When water has become scarce or when quality of nearby supplies has diminished, it has become customary for Eastern Massachusetts to move continually westward within the Commonwealth to seek more and better quality water. Because of an unbalanced population distribution within the state, Western Massachusetts with its relatively sparse numbers of people has fallen prey to the political pressures of the more populous Eastern sector. In the light of long-range planning and the present understanding of the limits to growth that any society must take into account, this headlong scramble for new, pure surface water for the M.D.C. must come to an end. The communities bordering the Connecticut River and its tributaries have need of the water within their own drainage basin. The State of Connecticut expresses increasing concern over the potential depletion of Connecticut River waters if the projected eight or more diversions which have been considered are put into effect. The diversions under consideration in the specific proposal at hand have within them the seeds of further diversions. It should be noted that citizens of the Delaware River Basin have sued New York City for diminishing the quantity and quality of Delaware waters (New York Times, 2 Nov. 1972). This is reminiscent of the Connecticut - Massachusetts suit over the building of the Quabbin in the first place, a case which could be reopened if detriment were shown downstream in Connecticut.

The mission-oriented focus of Corps' projects by its very nature precludes a full evaluation of alternative actions. For the Corps, under a Congressional mandate, to perpetuate an existing State pattern of water-grabbing from its less populated areas seems basically wrong.

Interestingly, a part of the proposed study had spurious origins.

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The idea for the Northfield diversion came from a utility executive seeking multiple justifications to gain a license from the Federal Power Commission for a pumped storage facility using the Connecticut River as a lower reservoir. The M.D.C. was approached by the utility, saw the potential of Northfield pumps for adding Connecticut River water to the Quabbin supply, and took over the diversion plan. This, then, fell to the Corps under the NEWS study in a secondary way.

The ultimate economics of the Quabbin as the distributing reservoir system for the Commonwealth is questionable. Will Holyoke, Northampton and Amherst, for example, end up drinking Connecticut River waters which have been pumped to Quabbin and back ? It would seem that diversification with the development of alternative sources of supply should be undertaken for several reasons.

1) For the public health and safety, it is important to have alternate sources which can be drawn on should one source become contaminated for a period of time. Surface water is particularly susceptible to pollution from airborne wastes or chemicals that may enter the supply. It is worth noting that in a statement prepared by Western Mass. Electric Co. for the Turners Falls dam, that the Turners Falls pool from which Northfield pumps, contains phenols from "0.0002 to 0.0004 ppm, well below toxic levels to fish but potentially capable of imparting an unpleasant flavor when combined with chlorine". (pg.62). And also, it is stated in the same place that " copper (up to 16 micrograms/L), lead (up to 108 micrograms/L) and zinc (up to 60 micrograms/L) exceed levels considered 'safe' by some biologists". It should furthermore be noted that the Miller's River will at times be drawn upstream by the pumping up of water through the Northfield pumped storage intake. Miller's water is rated unsatisfactory to D quality now, but is expected to improve to B within five years. Should Northfield operate as a diversion source prior to the cleanup of the Miller's River, potential contamination of the Quabbin ought to be considered.

2) Changing economics resulting from improved technology, and periodic reassessment of priorities should be factors in weighing alternatives. As the study stands, all the alternatives except the proposed projects are rejected. For example, however, as desalinization is becoming more economical, its feasibility ought to be investigated simultaneously with other alternatives, not separately at a later time when a decision on water diversion has already determined a course of action. Or in another instance, if production of protein food becomes a high priority in the next few years, the use of the Connecticut River for out-of-basin water supply could preclude adequate seafood production in the Connecticut River estuary. The Connecticut Basin diversions, it is claimed, would take only waste waters by flood skimming. This is not so because the natural fluctuations in river flow are a part of the evolutionary sequence basic to life in the river and its estuary. The time scale for change is in millions of years and man is a newcomer to an ancient system. (Speaking of 50 years as long term planning is naieve). Flood waters are necessary to the salt:fresh water balance in the estuary where during the

annual flood cycle important breeding grounds for shellfish and marine fish occur. Furthermore, the success of the entire anadromous fish restoration program depends on the excess flow of fresh water out of the mouth of the Connecticut River in late springtime.

3) The importance of developing ground water supplies has been badly under-emphasized. If Plymouth Co., or elsewhere, proves to have large reserves, the superficial preservation of a few recreational ponds is not adequate reason to ignore a pure, self-cleansing, and renewable (with proper care) source. Ground water development should be pursued actively now and recharge areas mapped and protected from imperviousness due to construction on top or other misuse of the sites.

4) The use of Quabbin waters for flushing purposes should be re-examined for the Chicopee River and the Charles River, or others, where this is practiced. Point sources of pollution should be attacked and cleaned up, such as Monsanto on the Chicopee. Flow regulation (as distinct from low flow augmentation) on the mainstem of the Connecticut River should be fully instigated at the 0.2 csm level, or as recommended by the State Division of Fisheries and Game and the Federal Bureau of Sport Fisheries and Wildlife. If the mainstem is regulated for an instantaneous, minimum continuous flow, then the Chicopee can be managed more frugally so as to let less Quabbin water go by to adjust levels at Hartford. This pertains solely to the existing Quabbin waters, for it should be clear that additional out-of-basin diversion is and has been (see our statements of 11 Jan. and 6 July 1972) unacceptable.

5) A reorganization of priorities within the M.D.C. is urged. The South Sudbury and Cochituate reservoirs and the Sudbury River should be cleaned up and used in the system. It is not right to use what was once drinking water for recreational purposes for some local residents, while penalizing residents in another part of the Commonwealth by diverting their water into a different drainage basin.

6) Finally the concept that what is good for Boston is good for the Commonwealth should be reconsidered. In the light of our present knowledge, it is unrealistic to think that material growth can persist indefinitely at the rate it has been, much less at an increasing rate. This involves the use of all natural resources, including water. The problem is, in part, one of public education. If the Corps can not assume this responsibility, then the Commonwealth must do so. To speak of brown lawns and depressed suburbanites is playing ostrich to the basic problem of the limits to growth. The reclamation of waste waters, water rates to encourage conservative use, water rationing, repair and replacement of poisonous lead piping (causing water to be run at the request of officials and thereby wasted), use of less-than-drinking quality water for industrial purposes and fire protection, revamped domestic plumbing systems, frugal use of air conditioning, and other such practices must become a part of the system.

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Educational field trips by bus to the Quabbin should be introduced into the schools of the M.D.C. service area so that every child comes to appreciate the tax on the environment that water use represents. It doesn't just come out of the pipe, it comes out of the Connecticut River Basin ecosystem, and it is a resource given that is in no way paid for, if one speaks of donors and receivers.

What the Connecticut Basin has to give as the best agricultural region in New England and a recreational area with the potential for a great salmon and shad sport fishery, should be carefully weighed against bleeding the Basin as a water supply. Reduced fertility of now rich floodplain soils and reduced life in the waters of the River and its estuary will be the result of continued out-of-basin water diversions.

References.

See bibliography of our 11 Jan. 1972 statement.
Foster, C.H.W. 1970. The Northfield Mountain Pumped Storage Project Counterpoint to Con Ed. Harvard Forest Paper No. 19, Petersham, Mass.
Meadows, D.L., et al. 1972. The limits to growth. New York: Universe Books.
Proposed Report of the National Water Commission, Chapter 8: 1-33. (It will be seen that arid regions have been primarily involved; we feel that other alternatives than water diversion should be fully examined for the New England region).

Sincerely yours,

Jane Van Zandt Brower

Jane Van Zandt Brower, Ph.D.

Chairman, Connecticut River Basin Task Force; Member, Executive Committee New England Chapter, Sierra Club.

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# APPENDIX B

# PREFACE

This Appendix summarizes the steps in the final preparation of the Impact Statement. It includes the coordination at the Washington level with Federal Agencies and the State and responses to their comments on the Draft Environmental Statement. Responses to their comments are grouped according to these agencies. There were also comments on the Main Report of the project - these are indicated where applicable in this Appendix B.

Future efforts aimed at improving the quality and quantity of environmental data available to management with responsibility for planning and developing this project should adequately resolve most of the questions raised by the agencies whose comments are included in Appendix B.

U.S. ENVIRONMENTAL PROTECTION AGENCY

Comment - The proposed aqueduct may be a point source discharge into Quabbin Reservoir which requires a NPDES permit. Our General Council's Office is in the process of making a determination. During preparation of the Final Impact Statement, our offices should work jointly to resolve this question.

Response - As the Final Statement was being prepared, proceedings were still underway to resolve the question of a permit. Recent correspondence has indicated that a permit will probably not be necessary.

Comment - The high quality of the drinking water in the Quabbin Reservoir necessitates a continuing and effective water quality monitoring system. Also, provisions for water treatment should be included in the long range plans.

Response - During the advanced engineering and design stages specific scheduling and a design of a monitoring program will be developed. At this time the requirement for necessary water treatment will also be determined.

Comment - The "best practicable treatment" of upstream wastewater which is recognized as being required in the Draft Statement may not provide the consistently high quality of water needed for diversion to Quabbin Reservoir. This can only be determined after plants are in full operation and an extensive water quality monitoring system is established as indicated in the Draft Statement.

Response - We agree that the project as proposed requires information which will be available only after treatment facilities are in operation.

Comment - The Draft Statement mentions the possibility of a "Y" connection in the tunnel aqueduct to Quabbin Reservoir. We feel the provision for full diversion of the flow to either the west or middle branch of the Reservoir would guard against possible short circuiting of the system. The Final Statement should more completely discuss the "Y" connection and make a more positive statement as to whether the "Y" is part of the proposed plan.

Response - As discussed in the report and in earlier agreements at meetings held with EPA officials, it was decided that the "Y" connection may be necessary. However, the actual need for the "Y" connection would be dependent upon water quality condition within the Connecticut River and Quabbin Reservoir during the period that the project is being designed.

U.S. DEPARTMENT OF INTERIOR

Main Report - Millers River Basin Water Supply Project

Comment - The project's proponents should indicate precisely where and what minerals occur and their relationship to the project. If any minerals are found or located in the project right-of-way, the project proponents should so indicate and give some estimate of the extent to which future recovery of these minerals will be affected. A map locating the known mineral resources in relation to the project vicinity would allow easier assessment. Any minerals preempted by the project should be described in the section "Irreversible and Irretrievable Commitment of Resources".

Response - The sand and gravel deposits described on Page 14 are the predominant mineral resources within the Millers Basin. Although peat and miscellaneous deposits also exist, they are not considered to be typical deposits which would be mentioned in this background type section.

The majority of the projects' facilities would be deep rock tunnel aqueducts. The geology of the tunnel routes is given in Appendix E to the Main Report. It is not anticipated that the tunnel construction would hinder further mining efforts.

Comment - The Millers River Basin fish habitat resources have not been adequately described on Pages 14-15. The anadromous fish restoration potential should be noted. The impact of diversion on this and improved resident fisheries resources should also be recognized and evaluated.

Response - The description of the Millers River fish habitat resources is considered adequate for the purposes of this background information section. Whereas the basin is not currently being contemplated for Atlantic salmon restoration, reference to future use of the basin for such purposes would be misleading to the reader.

A description of the impact of diversions on the existing and planned fisheries resource is included in Section IX, Project Impact Analysis. In addition, the control flows used in the operational procedure for the project was developed by U.S. Fish and Wildlife personnel and these were intended to minimize any impacts of the river's environment including the fishery.

Comment - A description of the environmental setting and natural resources of Quabbin Reservoir should be included in Section 6 of the main report.

Response - Appendix I of the report described Quabbin Riservoir in some detail. The evaluation given in the main report refers to this appendix and the data contained therein.

Comment - Control flows for the Millers River Basin diversions are presented as finite on Pages 61 and 66, but Fish and Wildlife Service understood that they were set at "best estimates" for planning. This should be clarified in the main report, as well as noting that leeway exists for adjustments as environmental considerations warrant.

Response - The control flow estimates shown on Pages 61 and 66 are indeed estimates prepared by the U.S. Fish and Wildlife Service under contract to the Corps of Engineers. Since a considerable amount of effort and money was expended in determining these figures, it is unclear as to why any significant variations should be expected.

Comment - Pages 144-145. The adverse fish and wildlife habitat impacts from pool fluctuations and erosion at diversion sites in the Tully complex are not addressed. It should discuss the loss or vegetation, silting of streams, restrictions to fish movements, turbidity and other impacts.

Response - Pages 144-145. The information given on pp 140-145 describes the effect on the area from the impoundments. Later on pp 156-157 the impacts of the Tully Complex alternative are discussed relative to the other Millers River Basin alternatives. In this discussion, the Tully Complex is described as having the most impact on the environment and is not the plan selected for implementation. The detail included in the discussion, therefore, was considered adequate for purposes of the report.

Comment - We recommend that the necessity for further studies presented in Appendices I and J be recognized in the Main Report, under the "Summary Conclusion" section.

Response - The studies discussed in Appendix I were initiated independently by the Metropolitan District Commission (MDC) prior to the completion of the subject study reports. The followup investigations recommended in Appendix J are primarily, as stated in that appendix, for information "which will be required as future demands arise for new uses of the river", i.e., actions beyond the subject report's projects. The Appendix J investigations recommended as part of the subject report's projects are a monitoring program and a hydraulic model of the river. The necessity for this program is described in both the Northfield Mountain and Millers River Basin reports in the section titled Description of the Project. The hydraulic model discussed will be constructed as part of the ongoing Massachusetts water pollution control program for the Millers and Connecticut Rivers.

Main Report - Northfield Mountain Water Supply Project

Comment - If fiscal and/or temporal constraints combine to delay the timely implementation of PL 92-500 (The Water Quality Act of 1972), water quality conditions may require that Connecticut River water be treated prior to diversion to Quabbin Reservoir. This differs from what was stated on Page xviii, Paragraph 2. Also, Page 57 of the Revised Draft Environmental Impact Statement notes, however, that the MDC plans to chlorinate diverted waters prior to their entry into the Quabbin Reservoir.

Response - There is no information available to us that indicates the scheduled improvements to water quality required under Public Law 92-500 have been modified.

Comment - Page xlv - on the statement "Studies should be conducted to determine .... the size of needed long-range water supply developments", it appears that conclusive evidence already exists to verify the need for measures to conserve and moderate water demand. The effect of any single conservation or demand moderation measure may indeed be insignificant, but the combination of several measures could have a sizable impact on the total water supply.

Response - On the question of conservation measures, the study reports recognize the need for further studies into the possible utilization of these techniques. Such studies would be conducted during the advanced engineering and design phase if the projects are authorized.

Comment - The "Recommendations" section (Pages 182-184) of the report fails to include recommendations for further environmental impact studies listed in Appendix E, Page 121, Volume III. We recommend these studies be listed in the main report.

Response - The recommendations section does not include the Appendix E recommendations for further study because as in the Millers River Basin report these recommendations pertain to "future demands", i.e., actions beyond the Northfield Mountain project.

Comment - Although the report discusses the probable effects of water diversion on the donor and receiver water systems, it does not address the expected cumulation of synergistic environmental effects of existing and planned power production, flood management, irrigation, industrial cooling and domestic water supply plans as related to water diversions. A consideration of the cumulative effects of water use on the donor riverine system should be included.

Response - The Northfield Mountain project, as described in the report, is an element of the 1980 Connecticut River Basin Plan recommended by the Coordinating Committee for the "Comprehensive Water and Related Land Resources Investigation, Connecticut River Basin". This study which considered water quality, power, outdoor recreation, anadromous fisheries restoration, resident fish and wildlife, water supply, navigation, upstream water and related land resource potential and flood control, had as one of its committee members, the Department of the Interior.

Environmental Impact Statement

Comment - The discussion of environmental impacts caused by construction makes no mention of the impacts or adverse effects on the existing or potential recovery of mineral resources in the project area. If this cannot be accomplished, a statement to this effect should be included in the Revised Environmental Statement.

Response - As noted in response to a 1972 comment on the Impact Statement we have included a general description of the geology of the region. This description was drawn from available data.

Comment - Because the project area is within Seismic Zone 2 where moderate damage can be expected, the Statement should discuss the possible effects of earthquakes.

Response - Advanced engineering and design considerations would include the possible effects of earthquakes on the project.

Comment - There is no discussion or adequate concern given to the protection of cultural resources, including archaeological values. Such commentary should be displayed in the Appendices and discussed in appropriate places in the text. In order to evaluate the magnitude of the affects on archaeological values, it was suggested for the Corps to consult qualified archaeologists as Dr. Maurice Robbins of Bronson University, or Dr. Dena Dincause of University of Massachusetts immediately, as well as with the State Historic Preservation Officer. Their commentaries should be displayed and discussed in the Environmental Statement.

Response - Federal regulations on historic and archaeological values were not as well defined during the study period as they are today. During the next level of planning the cultural and archaeological resources which may be affected by the project will be given further consideration. As noted in the Draft Statement, the State Historic Officer was contacted and advised us that no known sites would be impacted. Also the National Park Service was notified and they did not respond with any known historical or archaeological sites which may be affected.

Comment - Paragraph 2, Page 83, Line 7 - the second alternative is a combination of one and three is inaccurate and misleading. It would be more accurately described as combining Alternative One with an element of Alternative Three (the East Branch Tully River diversion).

Response - Agree.

Comment - Pages 40-45, biological resources of the Millers River Basin are not adequately described. A potential for Atlantic salmon restoration exists, and the impact that Millers River Basin diversions would have upon it should be recognized in appropriate sections of the Final Environmental Statement.*

Response - This is essentially the same comment which was responded to in the Main Report, Comment #6. As noted earlier, the description of the Millers River fish habitat resources is considered adequate for the purposes of this background information section. Whereas the basin is not currently being contemplated for Atlantic salmon restoration, reference to future use of the basin for such purposes would be misleading to the reader. *See also Federal Power Commission, April 14, 1976, Comment #1.

Comment - Pages 40-43 - it does not consider the impact upon the improved fishery resources following pollution abatement.

Response - This impact is discussed on Page 64 of this Statement.

Comment - Page 40, Paragraph 3 - last sentence should be corrected to show that pleasure boating, as such, is not permitted on Quabbin waters.

Response - The word pleasure boating was not used in the report. The word regulated was used in front of boating indicating that the boating activity was governed by a permit system administered by the Metropolitan District Commission.

Comment - Page 57, paragraph 2 - the MDC plans to chlorinate diverted waters prior to their entry into Quabbin. The statements concerning this reflect the considerable concern for Quabbin's water quality if diversions are made from the Connecticut and/or Millers Rivers. Alternatives to chlorination should be examined, with one being ozonation. Advantages for ozonation include a lower potential for accidents related to use of chlorine and availability is not dependent upon market conditions. When the cost of ozonation is compared to the cost of chlorination, the benefit/cost ratio is highly in favor of ozonation.

Response - Alternatives to chlorination will be examined in the advanced engineering and design phase. Included in this alternative will be chlorination and ozonation as well as other possible treatment techniques.

Comment - It is recommended that Table 7, Block 4, Page 60 be modified to show that fish species were intended to be designated under the heading: Introduction of Undesirable Species, as on Page 53 it was stated that undesirable algal species will be introduced.

Response - The table headings were meant to be all inclusive, and not limited to fish.

Comment - On Page 64, it is indicated that diversions "may shorten the (canoeing) season during lower flow periods in the late spring." This should be clarified as to the project operation and resulting impacts.

Response - It is felt that the description on Page 64 of the statement, which discusses impacts on canoeing in the mainstem of the Millers River, presented enough information at this level of planning for the reader to make a judgement.

Comment - We are concerned about the impact of water diversions on existing and potential recreation values, especially impacts which may occur during the major recreation use season. The proposed diversion dam will be a physical barrier to passage on the river and will effect flows in the river. The Statement should discuss measures that will be taken to minimize adverse impacts on the use of the river for recreation purposes.

Response - The diversion period for the project would be during high flow periods, which does not coincide with heavy recreational use of the river, except for the possibility of white water canoeing. The impact on canoeing is described on Page 64 of the Statement.

Comment - Page 94, Paragraph 5. Adverse fish and wildlife habitat impacts resulting from pool fluctuations and erosion at diversion sites are not addressed. It should be noted that the extreme fluctuations during the growing season would adversely affect both terrestrial and aquatic vegetation and also the fish and wildlife utilizing these plants for nesting, escape cover and/or food.

Response - In the Main Report, the information given on Pages 140-145 describes the effect on the area from the impoundments. Later on Pages 156-157 the impacts of the Tully Complex alternative are discussed relative to the other Millers River Basin alternatives. In this discussion, the Tully Complex is described as having the most impact on the environment and is not the plan selected for implementation. The detail included in the discussion, therefore, was considered adequate for purposes of the report.

Comment - Page 113 - Diversions from the Merrimack and other sources to extend the water supply from the Northfield and Millers River diversion are presented. It is not clear in the order in which these diversions would be implemented. The order should be clarified and if these diversions are to be instituted in a stepwise progression, the need for each project should be reviewed prior to implementation.*

Response - The descriptions regarding possible diversions from the Merrimack and other sources are given to present alternatives to the Northfield Mountain and Millers River projects, not to replace these projects. As the Northfield Mountain and Millers River Basin projects are constructed, the majority of the eastern Massachusetts water supply needs will be met until almost the turn of the century. This allows time for new techniques and pollution abatement which would influence the choice of projects, both Northfield Mountain and Millers River. *See also New England River Basins Commission, April 16, 1976, Comment #4.

Comment - Page 134. The statement "No known endangered species of birds or animals listed by the Fish and Wildlife Service utilize the proposed project lands.", should be revised. The short nose sturgeon (*Acipenser brevirostrum*) has been collected in the vicinity of Montague, and the Quabbin Reservoir land area contains a site as a potential location for future reintroduction of the American peregrine falcon (*Falco peregrinus anatum*). Both of these are on the "Endangered Species" list. It is recommended that the planners should consult with the Peregrine Falcon Recovery Team during the planning processes. From a review of the status of the bald eagle from the Department of Fish and Wildlife Service, it is considering the potential for including those bald eagles which frequent New England on the "Endangered Species" list. Representatives of the southern bald eagle migrate into New England during the non-breeding season; hence the present status review and potential for extension of the listing to include birds in the project area. Future Environmental Impact Statements should include a discussion of endangered plant species affected by project implementation.

Response - At the time the study was made the original statement held true. We anticipate as further studies are made by Fish and Wildlife Service additional birds, plants and animals may be added to the list.

We expect the coordination with the Fish and Wildlife Service will continue on this program when planning on the project progresses to the next stage.

Comment - Diversions from different river systems would provide significant additional water supplies to the MDC service area. While tapping one area to provide a resource required by another may solve the immediate problem, the ecological ramifications are likely to increase as additional supplies are needed. There is a need to study further means of lowering existing trends in water demand.*

Response - See response to Department of Interior, Comment #8.

*See also New England River Basins Commission, April 16, 1976, Comment #1.

DEPARTMENT OF TRANSPORTATION - U.S. COAST GUARD

Northfield Mountain Water Supply Project

Comment - The cost of improving the water quality in the Connecticut River at Northfield should be included in the cost of the project.

Response - Improving the water quality in the Connecticut River is required under Public Law 92-500. This Federal law mandates that the river be cleaned up regardless of whether or not the project which is the subject of this EIS is constructed.

Comment - Because the ability of the existing distribution conduits and aqueducts to handle the increased service is questioned, the cost of improving the present MDC distribution system to handle the additional water made available should be included.

Response - An analysis was made of the primary transmission aqueduct from Wachusett Reservoir into the Boston Metropolitan area. On the basis of this analysis, it appears some operational changes would be necessary to allow the system to meet its maximum demand through 1990.

Comment - "A preliminary contingency plan to protect Quabbin Reservoir in the event of an industrial mishap at an upstream papermill or an upstream oil spill on the Connecticut River would be highly beneficial to evaluate the potential consequence of the project."

Response - Design of a water quality monitoring plan would be included in the advanced engineering and design phase. Included in this program would be development of a contingency plan as suggested. In the case of the Northfield Mountain project, for example, no pumping of river water would take place if deleterious material were present in the water.

Comment - All available reasonable alternatives have not been mentioned in the report. The use of the Charles River and the Mystic River are not mentioned.

Response - The water supply setting, included in the statement, did discuss the potential of developing locally available supplies.

Comment - No mention is made of the existence of groundwater potential in communities presently served by the MDC.

Response - This is true, the reason being that the report centered on major known groundwater supplies, i.e., those which could meet the demand defined by the study. Both local surface and groundwater sources were investigated to determine the role they might play in meeting the region's future needs.

Comment - In the section on alternatives, a condensed version of the University of Massachusetts report on "Water Usage in Communities served by the Metropolitan Commission" should be included.*

Response - The Council on Environmental Quality's recent guidelines requested that reports, voluminous inventories and similar data not be included in the Environmental Impact Statement, but be available at the sponsoring agency's office. Briefly, the University of Massachusetts report intimated that a large amount of unaccounted for water is leaking from the City of Boston distribution system. That the water is unaccounted for is concurred in but the conclusion that the water is leaking is not. Follow up work to confirm or refute the report's findings is currently underway. *See also New England River Basins Commission's April 16, 1976, Comment #6.

Comment - It is hoped that the Final Statement would have a section dealing with potential population redistribution, if any, from the Boston area to the central areas of Massachusetts if the proposed project is not implemented.

Response - The state of the art regarding a linkage between water supply projects and population-economic distribution is not clearly defined at this time.

Main Report

Comment - Section IX of the main report, and Appendix F were difficult to understand as to the criteria for forming the ten community clusters. If all the towns in each cluster are implied to be similar, we totally disagree with the clustering and suggest rewriting the section. We fail to understand how a town like Weston where the average house is valued in excess of $90,000 is a moderate income area.

Response - We have reviewed the cluster within which Weston falls, and our studies indicate that the other included communities are similar in composition.

Millers River Water Supply Project

Comment - Some mention of the possible secondary effects of this action on the area should be included as Section H of the report points out how the project will promote recreational use of the waters in the area. Such effects as possible increased auto traffic from outside the region to use the recreational facilities should be mentioned.

Response - The possible secondary effects of increased use brought about by the project would be included as an area of investigation when firm recreational proposals are developed.

Comment - The Statement should show why the Millers Project cannot be implemented without the Northfield Project being implemented.

Response - The Millers River and Northfield Mountain projects are independent actions which can proceed by themselves. Estimates of future water demand through 1990, however, indicate both projects would be necessary.

Comment - A preliminary contingency plan to protect Quabbin Reservoir in the event of an industrial mishap or oil spill on the Millers River would be highly beneficial to evaluate the potential consequence of the project.

Response - See response to U.S. Coast Guard, November 5, 1975, Comment #3. Same basic response applies to Millers River Diversion.

STATE OF NEW HAMPSHIRE - Water Resources Board

Comment - We have not reviewed the project since it does not involve any interests within our jurisdiction in the State of New Hampshire.

Response - None needed.

STATE OF VERMONT - Agency of Environmental Conservation

Comment - In reference to the two proposed reports of the Chief of Engineers on Northfield Mountain and Millers River Water Supply Projects, Massachusetts, the State of Vermont does not desire to comment.

Response - None needed.

THE COMMONWEALTH OF MASSACHUSETTS - Executive Department

Comment - We anticipate that the reports will be well received by Congress, and that the Corps will receive the necessary funding to pursue its work on these important projects.

Response - None needed.

Comment - We wish to acknowledge the conclusion of the Chief of Engineers and the Board of Engineers that a formal agreement between the State of Connecticut and the Commonwealth of Massachusetts need not be a prerequisite to further Corps' involvement in the project.

Response - None needed.

Comment - We understand that the proposed reimbursement arrangements will be in accordance with the Water Supply Act of 1958. Upon completion of engineering and design work, the Commonwealth will be prepared to consider the matter of assurances, and to explore the legal and financial issues regarding expansion of the Metropolitan Water District.

Response - None needed.

FEDERAL POWER COMMISSION

Comment - There is no discussion of the fish passage facilities planned at Turners Falls or the effects of the proposed diversion on the later planned reintroduction of shad and Atlantic salmon runs above the Turners Falls Project. Recent fisheries studies at the pumped storage project by Massachusetts should help identify problems of fish protection, such as the hazards of anadromous and resident species being drawn through pumps, in order to revise this discussion in the Draft Environmental Statement.*

Response - At the time of the study in the early seventies it was unclear that fish passage facilities would be placed at Turners Falls. We have reviewed the suggested report and did not find enough pertinent information to include in this report. However, this information and further information which may be developed in the interim will be used as a base to proceed with studies during the advanced engineering and design stages. *See also U.S. Department of the Interior, October 29, 1975, Draft Environmental Statement Comment #6.

Comment - There is no discussion of the impacts of the generation of electrical energy needed to pump the water for the proposed water supply project from the Connecticut River to the Northfield Mountain upper reservoir.

Response - At this stage of planning there is no indication that the project would have a major impact on the region's generating capacity. The reason being that the electrical generation during off-peak period when demand is normally low will be the electricity used for the pumping. Therefore we do not discuss the impacts as they could not be determined to be a significant action.

Millers River Basin Water Supply Project

Comment - Review by the Commission staff indicates that the proposed project would not be adaptable to the economical development of hydro-electric power. The project apparently would not significantly affect power production or the transmission of electric power or natural gas.

Response - No response necessary.

Comment - A number of hydroelectric power plants, many licensed by the Commission, are located on the Connecticut River downstream from the confluence with the Millers River. A discussion of the effects of the proposed diversion of flood flows from the Millers River on these plants should be included in the report and the Draft Environmental Statement.

Response - Because diversion will take place during high flow periods, flow remaining in the Connecticut River after diversion would be greater than flow capacity of the existing downstream stations.

NEW ENGLAND RIVER BASINS COMMISSION

Comment - An addition of 78 million gallons per day (mgd) by 1990 and 141 mgd to the water supply of communities served by the Metropolitan District Commission (MDC), is predicted by the Southeastern New England (SENE) Study and the Northeastern U.S. Water Supply (NEWS) Study respectively. Timing and the need for more research on alternatives to and impacts of the Millers River project make this an important difference. With respect to alternatives the SENE Study would give greater emphasis to conclusions that accelerated research should be carried out regarding (1) pricing as a means of water demand management, (2) public education as a means to encourage water conservation, (3) the cost-effectiveness of water saving devices, and (4) elimination of health hazards in recycling wastewater for domestic use. The potential of industrial recycling of wastewater and changing the rate structure for high volume water users so as to increase publicly supplied water for domestic use should be emphasized.

Response - Many of the comments on the reports are created by the adoption of certain assumptions in the Southeastern New England

(SENE) study which differ from those used in the Northeastern Water Supply (NEWS) study. For example, the demand projections developed by SENE estimate only an eleven million gallons per day (MGD) increase in the Boston Municipal demand for the period 1970-1990. This limited increase shown by SENE is in marked contrast to past trends within the city. In fact, during 1975, Boston used as much water as SENE has estimated for 1980. Use of the SENE estimates, based on Boston's experience, could prove to be a lower limit of future needs. We believe conclusions drawn from these forecast demands regarding project selection and implementation must be somewhat guarded. Both the NEWS and SENE studies recognize the need for wise use of our valuable water resources. In this regard, both investigations made recommendations as to the need for further study into water conservation measures, and we see no great difference in the report findings. In fact, the item pertaining to the recent water usage study prepared for the Metropolitan District Commission (MDC) noted in your letter, refers to a study prepared as part of a joint MDC-Corps' effort to determine current usage patterns such that appropriate conservation measures could be directed toward areas of need.

Comment - The SENE Study recommends increased research into the techniques of economically feasible, environmentally safe desalination as a long-range method of meeting Southeastern New England's water needs.

Response - With regard to desalting there appear to be no conflicts between the SENE recommendations for increased research and the conclusions drawn in the Impact Statement. Reference is made to pages 101-105 discussing the potential of desalting as a supply source for the region.

Comment - Unlike the NEWS Study, which rejects to the Plymouth County ground water as a possible alternative source of water for the MDC on the basis of its cost, the SENE Study has found that most of the Plymouth County supplies would probably be needed to meet local, in-basin needs. This finding is also consistent with the SENE Study's overall principle of encouraging local use of water supplies over interbasin transfers.

Response - There does not appear to be a conflict between the SENE report, which recommends local use of Plymouth County groundwater, and the conclusions given in the Impact Statement on pages 108-113.

Comment - Problems of poor water quality in the Merrimack River and the expense of its treatment lead both the NEWS and SENE studies to view this source of supply only as a long-range alternative to meet the MDC needs, and the SENE Study endorses continuing study of this option. Again, the implications of interbasin transfers will have to be considered.

Response - It is agreed that the implementation of interbasin transfer of water in tthe Merrimack River will have to be seriously considered in future planning to meet the long term water needs of the Eastern Massachusetts area. See also U.S. Department of the Interior, October 29, 1975, Comment #14.

Comment - The NEWS Study has stated that development of a diversion from the Sudbury River would be fully compatible with the projects. If the MDC estimate of an additional 40 mgd being made from this source in the near future is correct, this, with the water from the Northfield Mountain diversion, could be sufficient to meet the 1990 needs as projected by the SENE Study. This could affect the timing of the Millers River project.

Response - The potential of developing the Sudbury River is included in the EIS. As described in that statement it is estimated this increment could cost about twice that of the Northfield Mountain or Millers River water.

Comment - A recent study, prepared for the MDC by the Water Resources Research Center at the University of Massachusetts and Curran Associates, Inc., reports that if leaks and breaks in the MDC communities distribution systems, which exceed 3,000 gallons per mile of main per day, were corrected, 47 mgd or more might be saved. The findings of this report should be investigated and verified.

Response - See Coast Guard Comment #6.

Comment - The Commission's 1980 Connecticut River Basin Plan recommends that all diversions from the basin be conditioned on water quality monitoring and recognition of the basin communities' right of return of these waters when needed for water supply or flow augmentation. The Millers River project and other diversions are recommended only if certain conditions are met: (1) establishment of water allocation mechanisms giving downstream states a voice, (2) prior evaluation of economic, environmental and social impacts, (3) continued water quality monitoring, and (4) determination of the adequacy of Connecticut Valley groundwater resources. The SENE Study predicates its approval of the Northfield Mountain and Millers River projects on the fulfillment of the Plan's conditions.

Response - As stated, the SENE recommendations are qualified as they are predicated upon certain conditions discussed in the 1980 Connecticut River Basin plan. The plan formulation for both Millers River and Northfield Mountain was conducted with full knowledge of the 1980 plan.

Comment - The Chief of Engineers states it will not be necessary to stipulate the establishment of an agreement between Massachusetts and Connecticut on the diversion issues as a condition for Federal participation. However, the Board of Engineers for Rivers and Harbors, in giving reasons warranting Federal participation in funding the project, has given reasons which show the necessity of an agreement between the states. The statements include the following:

"The project would have interregional and interstate impacts (emphasis added);

"The project(s) involves regional equity issues" (emphasis added);

"The project(s) involves resolution of interbasin water transfer issues" (emphasis added).

The Federal Government should require that the two States establish a mechanism to allow downstream interests a voice in water supply allocation.

Response - The question of the requirement for a regional mechanism prior to participation by the Federal Government in the projects was discussed by the Board of Engineers for Rivers and Harbors. The Board was convinced that "resolution of any jurisdictional claim associated with the project can be approached best through the mechanism of requiring local assurances to hold and save the United States free from water rights claims rather than stipulating specific their sovereign prerogatives." Although we understand your concern, we feel the Board's approach is the best practicable solution from the Federal Government's perspective.

Comment - In Section 3 of the Revised Statement the discussions of the diversion's environmental impacts are often not supported by quantitative data. This is particularly disturbing in the case of the Millers River project, it is estimated that as much as 55 and 74 percent of the Millers and the Tully Rivers' flows respectively may be diverted during an average year (Environmental Statement, pages 62 and 65.). The Environmental Statement asserts that "in no case would the flow in the river be reduced below the established rate necessary to protect the river environment" (pages 62, 65). The absence of information to confirm this should be corrected.

Response - The comment on the discussion within the revised draft

Environmental Statement is well taken. As the SENE Study, the Connecticut River Supplemental Study have found, impact assessment in many ways is a subjective procedure and one in which exact quantification is not always possible. It is believed that the data available does allow a decision regarding the impacts on the river environment.